The Engineer

LONDON, FRIDAY, JANUARY 10, 1941.

PUBLIC NOTICES

CROWN AGENTS FOR THE COLONIES

COLONIAL GOVERNMENT APPOINTMENTS

Applications from qualified candidates are INVITED for the following POST :—

ASSISTANT ENGINEER REQUIRED for the Malayan Public Works Service for three years with possible permanency. Salary 400-25-800 dollars a month. (The Government rate of exchange is now 2s. 4d. to the dollar.) A children's allowance is payable to married officers with children. Free passages and, if married, subject to certain conditions, for wife and family also. Liberal leave on full salary. Candidates, age 23-26, must be Corporate Members of the Institution of Civil Engineers, or hold an Engineering Degree recognised as granting exemption from Sections A and B of the A.M.I.C.E. Examination; but students of the Institution between the ages of 23 and 25 years who have passed the A.M.I.C.E. Examination are eligible for appointment. In either case, candidates should have had at least two years' practical experience on Engineering Works after taking their degree or completing articles, at least one year of which should have been spent in a drawing office.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, and mentioning this paper, to the CROWN AGENTS FOR THE COLONIES, 4, MILLBANK, LONDON, S.W.1, quoting M/9306. 7029

UNION OF SOUTH AFRICA

CITY OF PRETORIA

TENDERS FOR STOKER FIRED BOILERS COMPLETE WITH AUXILIARIES; ALSO STEEL FRAME BUILDINGS FOR BOILER AND TURBINE HOUSES

The City Council of Pretoria invite TENDERS for the SUPPLY, DELIVERY and ERECTION of :

TWO, or ALTERNATIVELY FOUR, STOKER-FIRED BOILER UNITS, complete with Mechanical Draught, Dust-extracting, Ash and Coal-handling Equipment, and two Chimneys; also Steel-frame Buildings for Boiler and Turbine Houses.

One copy of the specification may be obtained from the Consulting Engineers, Messrs. Mers and McLellan, 32, Victoria Street, London, S.W.1, on or after 15th January, 1941, on payment of a fee of £5 5s.

Additional copies of the specification may be obtained from the Consulting Engineers in London on payment of £2 2s. for each such additional copy.

Sums paid on any number of copies up to four will be refunded on receipt of a bona fide Tender.

Sealed Tenders with all relative documents, endorsed "Tender for Boiler Plant and Buildings, Pretoria," must be delivered in triplicate as follows :—

(1) The original Tender and documents to the SECRETARY TO THE TENDER BOARD, OFFICE OF THE HIGH COMMISSIONER FOR SOUTH AFRICA, SOUTH AFRICA HOUSE, LONDON, W.C., not later than 17th March, 1941.

(2) Two duplicate Tenders and documents to Messrs. MERZ and McLELLAN, 32, VICTORIA STREET, LONDON, S.W.1, not later than 24 hours after deposit of the original Tender and documents with the High Commissioner.

The Council do not bind themselves to accept the lowest or any Tender. 7031

CITY OF COVENTRY

WATER DEPARTMENT

APPOINTMENT OF ENGINEERING ASSISTANT

Applications are Invited for the POST of ENGINEERING ASSISTANT at a salary (on General Grade 1 of the Council's salary scale) of £260 per annum, rising, subject to satisfactory service, by annual increments of £15 to £350 per annum (with the addition of a temporary cost-of-living bonus at the rate of 6 per cent. upon the first £300 of salary per annum and 3 per cent. upon the remainder).

All appointments made during wartime are, under the Council's rules, to be temporary only and for the duration of the war.

Candidates, who must not be over 40 years of age must be competent surveyors, levellers, and good draughtsmen, and should be qualified by examination.

The person appointed will be required to pass a medical examination, to contribute on the approved scale to the Superannuation Fund established by the Council under the Superannuation Acts, and to devote the whole of his time to the duties of the appointment.

Applications, endorsed "Engineering Assistant," stating age, qualifications, present occupation and experience, and accompanied by copies of not more than three recent testimonials, must be delivered at the office of the undersigned not later than Thursday, the 23rd January, 1941.

Canvassing, either directly or indirectly, will be a disqualification.

NORMAN J. PUGH,
Assoc. M. Inst. C.E., M. Inst. W.E.,
Water Engineer and Manager.

Council House,
Coventry.
December 30th, 1940. 7021

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

TO ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

ASSISTANT EDITOR REQUIRED in London for long-established Engineering Journal; must have good experience of Machine Tools, Workshop and Technical Office Practice.—Address, with full particulars and salary required, P3005, The Engineer Office. P3005 A

The Engineer

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PAPER ECONOMY

It has now become necessary, in order to maintain the normal circulation of THE ENGINEER, to print all advertisement pages on the Thin Paper hitherto used for the Foreign Edition.

So long as our diminishing stocks of thick paper will allow, the Home Edition Editorial pages will be printed on the usual paper, so that uniformity in bound volumes may be maintained.

PUBLIC NOTICES

GOVERNMENT OF THE PUNJAB

INDIA

Applications are Invited for THREE APPOINTMENTS of ASSISTANT EXECUTIVE ENGINEER in the Punjab Service of Engineers, Class 1. Candidates must be European British subjects of non-Asiatic domicile, and must have attained the age of 21 and have not attained the age of 24 years on the 1st August, 1940. They must possess one of a specified list of University Degrees or other qualifications. Permanent and pensionable appointments subject to two years' probation, with prospects of advancement to the highest posts in the Service. Initial pay, Rs. 300 per mensem, plus overseas pay Rs. 150 per mensem (total equivalent to £405 p.a. approximately). Free passage to India and if confirmed in appointment, further passages for purposes of leave. Further particulars and forms of application may be obtained on application by postcard, quoting Appointment 1/11/A, from the HIGH COMMISSIONER FOR INDIA, GENERAL DEPARTMENT, INDIA HOUSE, ALDWYCH, LONDON, W.C.2. Last date for receipt of applications 24th January, 1941. 6842

SITUATIONS OPEN

IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

STATUTORY RULES & ORDERS 1940 No. 877
RESTRICTION ON ENGAGEMENT ORDER

CEYLON.—GENERAL ENGINEERING ESTABLISHMENT REQUIRES, as near as possible to the following specification, well-educated MECHANICAL and ELECTRICAL ENGINEER with personality, single, under thirty, regularly trained, with indenture, technical qualifications essential. Drawing Office Experience, knowledge of the Business Side, including Estimating, Costing, Correspondence, and Salesmanship, are necessary, with ability to Meet Competition and Secure Orders. Capable of Directing Native Staff, Interviewing Clients, knowledge of Bookkeeping and Records a distinct advantage.—Address, stating salary required, 7023, The Engineer Office. 7023 A

SITUATIONS OPEN

ENGINEER'S ASSISTANT WANTED. Must be good Draughtsman and capable of Simple Surveys. State experience and last salary.—Address, 7026, The Engineer Office. 7026 A

MESSRS. DAVID BROWN and SONS (HUDD), Ltd., REQUIRE a METALLURGIST or CHEMIST for Research Laboratory, having Engineering Works Experience, preferably with specialised knowledge of Heat Treatment and Metallography of High-speed Steel or of Physical Chemistry of Gases. No routine work.—Graduates between 23 and 35 years of age should apply in writing to PERSONNEL CONTROLLER, Messrs. David Brown and Sons (Hudd), Ltd., Meltham, near Huddersfield. 7025 A

OLD-ESTABLISHED COMPANY of ENGINEERS in Yorkshire, operating Mixed Ironfoundry up to 30 tons per week, DESIRE to RETAIN SERVICES of FOUNDRY CONSULTANT and METALLURGIST to Advise on Mixtures for High-class Castings and Certain Reconstruction Work.—Address, terms, &c., 7083, The Engineer Office. 7083 A

THE Post You Are Seeking May Not be Advertised in this Column, but do not lose the Opportunity of Bringing Your Requirements before all those who would be interested and could employ you. An Advertisement in the "Situations Wanted" Column would be seen by all Leading Engineering Concerns for a cost of Four Lines, 4s.; 1s. for each Additional Line. There is no better way of covering so large a field for such a small charge.

WORKING ESTATE ENGINEER WANTED, single. Private Sanatorium, North Wales. Practical knowledge Boilers, Electric Plant; general House Repairs and Maintenance. Board lodging found.—Apply, stating wages, age, with copies of recent testimonials, MEDICAL SUPERINTENDENT, Vale of Clwyd Sanatorium, Ruthin. 7032 A

WORKS MANAGER REQUIRED for Factory engaged on Machining Aircraft Details and the Erection of Aircraft Assemblies. Only men with experience in detail planning need apply. This position is for a firm of good standing in the South Midlands.—Applicants should state full details of past experience and present position to Box No. 3346, T. B. Browne's Advertising Offices, 163, Queen Victoria Street, London, E.C.4. 7017 A

WORKS MANAGER, Light Engineering, REQUIRED for Scottish Branch of London Company. Must have up-to-date knowledge all types Machine Tools, Multi-spindle Autos, &c.—Address, stating age, experience, salary, 7024, The Engineer Office. 7024 A

SITUATIONS WANTED

A.M.I.C.E., A.M.I.M.E. (50), Railway Locomotive works, D.O., running shed training, wide experience public works and general engineering, experience reorganisation, control of staff, resources and initiative, applicable to many industries, at present chief engineer, municipal transport system, electric traction, I.C. and C.I. engines, DESIRES CHANGE.—Address, P3001, The Engineer Office. P3001 B

B.T.H. STUDENT APPRENTICE, Grad. I.P.E. H. Nat. Cert. (Elect.), H. Nat. Dip. (Mech.), electrical, draughting and planning experience with leading firms, DESIRES POST as ASSISTANT WORKS ENGINEER or similar. Age 27, free. Min. salary £400.—Address, P3006, The Engineer Office. P3006 B

CHIEF INSPECTOR, A.I.D. Approved, Available for this or other EXECUTIVE POSITION. Extensive aircraft and armament experience, apprenticeship, progress, liaison, &c.; organising and administrative ability; 35.—Write, BM/STRY, London, W.C.1. P3004 B

IF the Man You are Seeking is Not Amongst those Advertising in this Column, a Small Announcement in the "Situations Open" Column will Quickly and Economically Produce the Right Selection of Applicants, at the same time Eliminating Waste of Effort, Waste of Time, and Waste of Opportunity. The charge is Four Lines or under, 4s.; each Additional Line, 1s.; Box Numbers, 6d. extra, which includes despatch of all replies.

RESIDENT ENGINEER, Chartered Mechanical, long experience construction steel, concrete, hydraulic, and power. Age fifty. Good organiser.—Address, P3002, The Engineer Office. P3002 B

WORKS MANAGER (38). A.M.I. Mech. E., A.M.I.E.E., graduate engineer, shop trained, extensive experience in light to medium engineering products. Excellent record as works manager in securing increased and more economical production.—Address, P3003, The Engineer Office. P3003 B

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CLASSIFIED ADVERTISEMENTS CLOSE FOR
PRESS—NOON WEDNESDAYS

The Engineer
Annual Subscription Rates
(including postal charges).

BRITISH ISLES	£3	5	0	
CANADA	£3	3	0	Thick Paper Ed.
	£2	18	6	Thin Paper Ed.
ABROAD	£3	7	6	Thick Paper Ed.
(except Canada)	£3	3	0	Thin Paper Ed.

"THE METALLURGIST."

This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER each alternate month. Next date, February 28th.

ADVERTISEMENTS.

The charges for Classified Advertisements are 1/- per line up to one inch—minimum charge 4/-; those occupying one inch or more at the rate of 12/- per inch. Orders must be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified advertisements cannot be inserted unless delivered before TWO o'clock on Wednesday afternoon.

Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

Postal Address,
28, Essex Street, Strand, London, W.C.2
Telegr. Address,
"Engineer Newspaper, Estrand, London."
Tel. Central 4565 (10 lines).

Vertical Milling Machines,
all geared, hardened and ground throughout, ball and roller bearings, swivelling head, 30" x 8" Table
HENRY MILNES LIMITED, Machine Tool Works, Ingleby Street, BRADFORD

HARRY F. ATKINS
M.I. MECH. E.
CONSULTING ENGINEER
(MACHINE TOOLS & PROCESSES)
OLD FLETTON
PETERBOROUGH

YOUR WORKPEOPLE ARE WILLING—

willing to help the RED CROSS by contributing One Penny each week from their pay to the

RED CROSS PENNY A WEEK FUND.

But before they can give practical expression to their willingness you are asked to do your part by giving facilities for the voluntary weekly deduction to be made.

This may cause you some inconvenience, but you won't mind that. You will not stand between your staff and the urgent needs of a great cause.

24,000 EMPLOYERS

are making it possible for 3,000,000 workers to provide the RED CROSS with a regular additional income with which to meet all emergencies.

Enormous sums are being spent in aiding air raid victims—a special obligation. The Penny-a-Week contributions means so much to this essential Red Cross service.

Give your employees the chance to join this host of willing helpers —Phone Chancery 5454.

Red Cross thanks this newspaper for the free gift of this announcement

Manufacturers' Catalogues.

"The Engineer" will be glad to receive catalogues, lists of manufacturers' trade names, etc., from firms for inclusion in the files of the Enquiry Department.

FORGINGS
FOR ENGINEERING ETC.

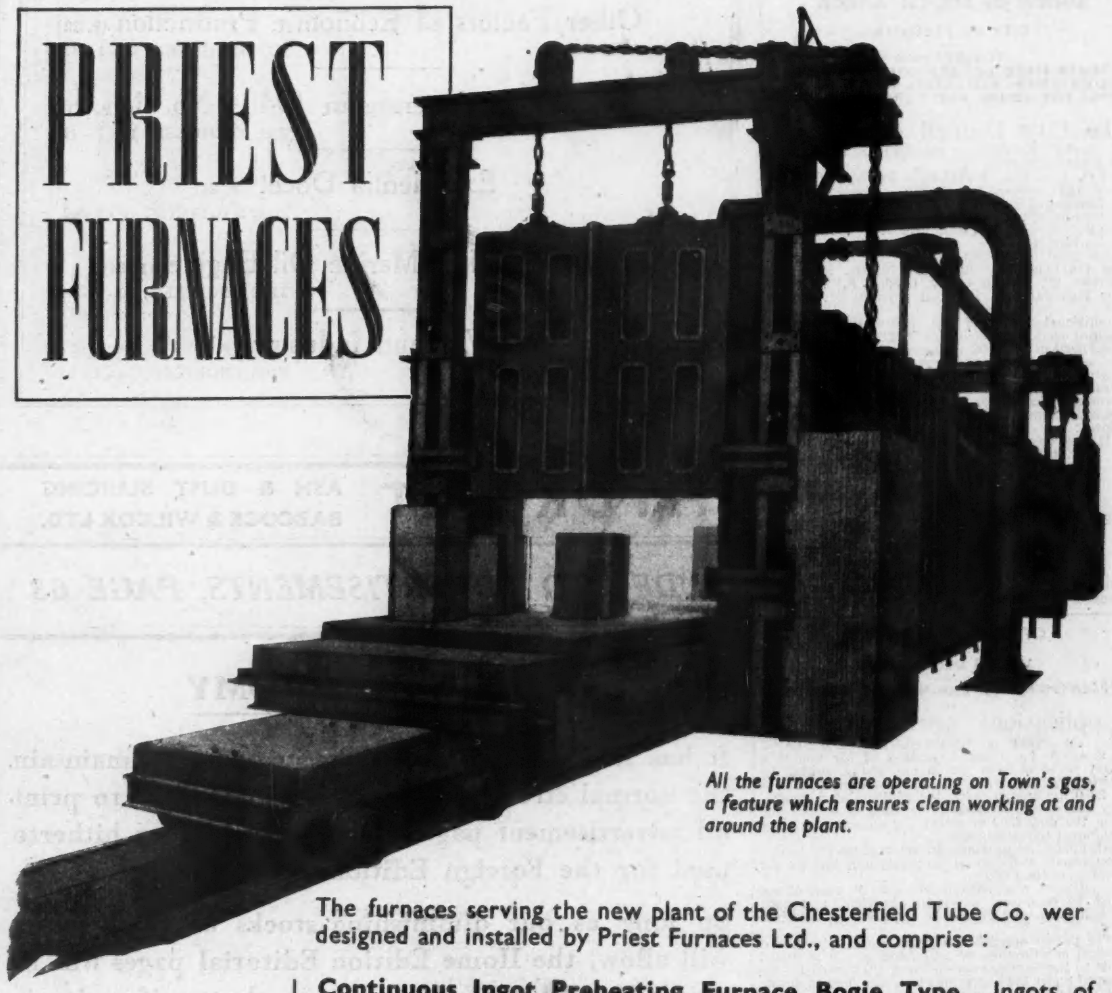
W. B. CULL & SONS, LTD.
ENGINEERS & GENERAL SMITHS.
(ALSO GENERAL MACHINISTS)
TENNANT STREET. BIRMINGHAM.

PROMPT DELIVERY.
COMPLETE PIPELINES
FOR HIGH & LOW PRESSURE STEAM, WATER, COMPRESSED AIR & OIL.
REISS Engineering Co. Ltd.
399, Hendon Way, London, N.W.4.
HENDON 6298.

MIXERS & EDGE RUNNER GRINDING MILLS
Smedley Bros Ltd
BELPER, DERBYSHIRE
FOR ALL PURPOSES

We extract the DUST FROM INDUSTRY
SPENCER & HALSTEAD Ltd OSSETT

PRIEST FURNACES



All the furnaces are operating on Town's gas, a feature which ensures clean working at and around the plant.

The furnaces serving the new plant of the Chesterfield Tube Co. wer designed and installed by Priest Furnaces Ltd., and comprise :

1. **Continuous Ingot Preheating Furnace Bogie Type.** Ingots of varying sizes and weights up to 20 tons maximum are preheated in this furnace, which is divided into two zones, preheating and soaking. The Soaking Zone is of our Priest Patent Cross Fired Multiple Pass Regenerative Type, capable of heating small and medium size ingots to final temperature for piercing.

2. **Soaking Pit.** Large ingots are transferred from the preheating furnace to the Soaking Pit for the final heating. The Soaking Pit is also designed on our Multiple Pass Reversible Regenerative System.

3. **Tube Reheating Furnace.** This unit is of the Continuous Recuperative Type with inclined hearth ; the furnace is designed to give uniformity of temperature over the full length of the tubes with minimum scale formation.

PRIEST FURNACES LIMITED · LONGLANDS · MIDDLESBROUGH
ALSO AT TELEGRAPH BUILDINGS · HIGH STREET · SHEFFIELD

P.S.

A Seven-Day Journal

New Import and Production Executives

ON Monday evening, January 6th, it was officially announced from No. 10, Downing Street, that the Prime Minister, Mr. Winston Churchill, had set up new executives in order to obtain more rapid and decisive action in the war effort. The Import Executive, which is composed of the five Ministers who are the chief importers, will have as its duty the animation and regulation of the whole business of importation in accordance with the policy of the War Cabinet. It will consist of the Minister of Supply, Sir Andrew Duncan, who will be Chairman; the Minister for Aircraft Production, Lord Beaverbrook; the First Lord of the Admiralty, Mr. A. V. Alexander; the President of the Board of Trade, Captain Oliver Lyttelton; and the Minister of Food, Lord Woolton. The Minister of Transport, the Minister of Shipping and the Merchant Shipbuilding and Repair Branch of the Admiralty and other Ministries or Departments will render all necessary aid to the Import Executive in executing and implementing its decisions. The Minister of Agriculture will have ready access to the Import Executive, and the President of the Board of Trade will represent the interests of the lesser importing Departments. A Production Executive has also been set up, consisting of the Minister of Labour and National Service, Mr. Ernest Bevin; the Minister for Aircraft Production, the First Lord of the Admiralty, the President of the Board of Trade and the Minister of Supply. This Executive will give effect to the general policy of the War Cabinet and its functions will include the allocation of available sources of raw materials, productive capacity, and labour, together with the fixing of priorities where necessary. The Production Executive will replace the Production Council. The work of the Import and Production Executives and of the three existing Committees on Civil Defence, Home Policy and Food Policy will continue to be directed by a Committee on which the Chairmen of these bodies sit, under the chairmanship of the Lord President of the Council. This Committee is now constituted as follows:—Lord President of the Council, Chairman, The Lord Privy Seal, the Minister Without Portfolio, the Chancellor of the Exchequer, the Minister of Labour and National Service, the Home Secretary and the Minister of Supply. Mr. Arthur Greenwood, the Minister Without Portfolio, is to be the Chairman of a group of Ministers who will study post-war reconstruction, thereby paving the way for a Ministry of Reconstruction when the end of the war can be more clearly seen.

Naval Corvettes

QUITE recently reference has been made to the important part now being played by naval corvettes in meeting the submarine menace. The first mention of these useful ships was made shortly before the outbreak of war, by Mr. Geoffrey Shakespeare, then the Parliamentary Secretary to the Admiralty, who, in introducing the Supplementary Naval Estimates of 1939, stated that the Admiralty was placing orders for a number of anti-submarine vessels of the whale-catcher type. The name corvette has been revived to indicate this new type of naval vessel. It was recognised before the war that there was a definite shortage of anti-submarine craft for convoy work and hunting down enemy submarines, and at first a number of trawlers were utilised for such duties. It was then shown that the real need was for ships equally seaworthy, but with a higher speed and better anti-submarine armament. The ships are larger than a trawler, but smaller and less costly than a destroyer, and the design is such as to lend itself to rapid construction. Many of this new class of ship are now in commission, says the Naval correspondent of *The Times*, and they are serving a useful purpose, both in convoy work and in combating submarine attacks. Their design and construction necessitated special solutions of hull and propelling machinery designs which have been satisfactorily accomplished. The complement of a corvette consists of three officers besides the captain, and from fifty to eighty ratings are carried. This new type of naval vessel has now become well known to the Merchant Navy, which has been quick to recognise the excellent work it is capable of accomplishing. It is a good sea boat, and has given good results under winter conditions in the Atlantic and the North Sea. It is known to be lively in a seaway.

"Engineering"

WE trust we may be allowed as an elder brother to offer our heartiest congratulations to *Engineering* on the attainment of its seventy-fifth birthday. It is an interesting fact that our contemporary was founded by Zerah Colburn, who for some years had been Editor of THE ENGINEER. With him were associated two very able young men, W. H. Maw and James Dredge, whilst Henry Bessemer gave influential support to the new venture. Maw was a locomotive man twenty-seven years of age. He became Sub-editor, whilst Dredge, who was six and twenty, took charge of the illustrations. Dredge's interests were also mainly "railway." He had worked with D. K. Clark on his famous *Locomotive Engineering*, and subsequently with Sir John Fowler, who was then consultant for the Metropolitan District Railway. We may add that Colburn himself was still in the early thirties, so that the new paper had plenty of young blood in its veins. But Colburn did not remain long. He was an extremely difficult man to get on with, and in 1870 he relinquished the proprietorship of the paper to Mr. A. T. Hollingsworth, who then, at twenty-three years of age, had married a niece of Sir Henry Bessemer. A few months later Colburn returned to his native America, where he committed suicide. The collaboration of Maw, Dredge, and Hollingsworth was a very happy one. It soon developed into a partnership, and in 1891 the business was converted into a limited liability company. But in 1906 Dredge died and his place as assistant to Maw was taken by Mr. B. A. Raworth, who had been on the staff since 1882. In 1919 Raworth also died and was succeeded by Sir Alexander Richardson, who had been on the paper nearly thirty years. Dr. Maw's death occurred at a ripe age in 1924, and four years later the last of the founders, Mr. Hollingsworth, followed him to the grave. In concluding this brief record of the origin and rise of our great technical contemporary, may we express a sincere hope that it will flourish for many years to come, and with us continue to support a form of technical journalism which has now but few exemplars.

Empire Shipbuilding

IT is announced that shipbuilding yards in the British Empire are doing their share in providing replace tonnage. Recently it was announced that Canada is to build, in addition to naval ships, sixteen large merchant ships to the order of the British Government. Canada's principal shipbuilding yards are situated at Vancouver, Halifax, and Montreal, and already a large number of merchant ships are on the stocks. Altogether, the Dominion possesses some forty shipbuilding and ship-repairing establishments, and before the war as many as 4000 shipyard workers were employed in the Dominion. The ship-repairing returns show that in 1938 the amount of repair work carried out in Canada exceeded £3,000,000 in value. Canada is thus in a position to make an important contribution to the Empire's war shipbuilding programme. In South Africa the shipbuilding and ship-repairing industry is less strongly developed, but at Durban and Cape Town there are possibilities of future development. Durban already possesses a dry dock and excellent facilities for ship-repair work. In Australia shipbuilding was undertaken during the last war, but in recent years only a small number of vessels were built and repaired. Australia has shipbuilding yards at Sydney and Melbourne, and a further shipbuilding yard is to be established at Whyalla, in Southern Australia, with a capacity for merchant ships up to 12,000 tons. Orders for £250,000 of engines and machinery have recently been placed in Queensland, Australia, and Mr. W. M. Hughes has stated that shipbuilding will become one of the great national industries of the Commonwealth.

A North England Railway Centenary

SATURDAY, January 4th, 1941, marked the centenary of an important section of the London and North-Eastern Railway Company's East Coast main line. It was on January 4th, 1841, that the Great North of England Railway was formally opened between York and Darlington by the running of two coal trains from Darlington to the coal depôts at York. These first two trains consisted of 101 and 99 small coal wagons, which were hauled respectively by two locomotives of the neighbouring Stockton and Darlington Railway. It is on record that the locomotives of one train were the "Pilot" and the "Witton Castle," and those of the other train the "Magnet" and the "Tory." The trains, which were accompanied by two of the directors, the secretary, and the engineer of the railway company, together with other railway officials, travelled at an average speed of about 15 m.p.h. over the single track which connected the two towns at that period of railway history. The York to Darlington line was not opened for passenger traffic until March 30th, 1841, when two trains were run from Darlington to York and back to Darlington, a special temporary passenger station being provided at Darlington Bank Top. The trains travelled at the same average speed as the coal trains, and the journey occupied about three hours each way. The opening of this section of the railway completed the final link in the chain of railways which then existed between London and Carlisle. In later years the North of England line was absorbed by the Newcastle and Darlington Junction line, which later became the York and Newcastle line, and in 1847 the York, Newcastle, and Berwick line. In 1854 the line was renamed the North-Eastern Railway, and bore that name until it was merged into the London and North-Eastern Railway group in 1923. We may record that whereas two coal trains were run 100 years ago, the average scheduled coal trains between Darlington and York to-day number twenty.

The "Queen Elizabeth" at Cape Town

WE record with interest the safe arrival of the 85,000 gross ton Cunard White Star liner "Queen Elizabeth" at Cape Town, which she reached recently, sailing from New York by way of Trinidad, on the way to an undisclosed destination. In last week's issue we gave a view of the ship leaving the Clyde and commented upon the fine maiden voyage to New York, which was accomplished with excellent results, without the opportunity of making the usual trial runs associated with the testing of a large liner. It may be recalled that the "Queen Elizabeth" lay at her New York pier for about eight months before she received her sailing orders. She left New York for a secret destination and Trinidad was reached in four days and Cape Town ten days after leaving Trinidad. Her arrival at Cape Town was kept secret until a few hours before she was due. As in New York, the liner was given a rousing welcome, and was escorted to safe anchorage by bombers of the South African Air Force. She was commanded by Captain J. G. Townley, who commanded the "Queen Mary" and has served in many other famous ships of the line. We understand that her machinery operated, as on her maiden voyage, most satisfactorily. It is stated that at no time during the voyage did the liner travel anywhere near top speed. Further news from this fine ship will be awaited with no little interest.

A Fire Prevention Executive

ON Thursday evening, January 2nd, it was officially announced that the Prime Minister, on the recommendation of the Lord President of the Council, Sir John Anderson, and the Minister of Home Security, Mr. Herbert Morrison, has approved the immediate establishment of a special organisation to be called the Fire Prevention Executive. The object of this body will be to secure prompt and vigorous action by the various Government Departments and authorities in applying effective measures of fire prevention in target areas. Mr. W. S. Morrison, the Postmaster-General, has been appointed the Chairman of the new Executive, and Colonel Sir John Greenly will have administrative charge of the organisation. The new organisation will include responsible representatives of all the Government Departments concerned with the many aspects of the problem of fire prevention, and will work in close association with the Ministry of Home Security in matters within the responsibility of that Department. There is to be the fullest possible delegation of responsibility to the regions, and to smaller areas within the regions, and appropriate arrangements will be made for the supervision of the work in Scotland. The setting up of this new Executive follows quickly upon the decision of the Government to approve in principle the conscription, if need be, of fire watchers. These men, if it were thought desirable, could be enrolled compulsorily. The Act gives the Government full control in war time over the services of everyone, but it is expected that compulsion will not be necessary and will not be used should there be sufficient voluntary air raid precaution workers.

The Engineering Trade Unions' Wages Claims

ON Tuesday, January 7th, the claim for an increase in wages put forward by the Amalgamated Engineering Union was heard before the National Arbitration Tribunal, and the following day—Wednesday—was devoted to the hearing by the Tribunal of the claim put forward by the Confederation of Shipbuilding and Engineering Unions. Both hearings were in private, and the decision of the Tribunal will be heard in due course. While the claims, which were outlined in a Journal note of November 8th last, differ slightly in amount, the matters which were presented to the Tribunal, upon which it was asked to state its opinion, are not dissimilar. In the case of all the Unions, the answer given by the engineering and shipbuilding employers was substantially the same. They maintained that under present conditions the applications for a further increase in wages, if granted, would not, in the employers' opinion, be in the interest of the country unless it could be shown that the granting of them was a matter of imperative necessity, that the country could afford to pay, and that such payment would not represent an unreasonable balance in equity between engineering workers and other sections of the community, including our fighting men. The decision of the Tribunal on this important national issue is one which will be awaited by the industry with the keenest of interest.

The Mobilisation of Industry for the Purposes of War

EARLY in November, 1938, Mr. David Bremner, the director of the B.E.A., prepared a scheme which will repay study to-day in the light of subsequent events and present needs.

Through the courtesy of the British Engineers' Association, we are able to print the major part of Mr. Bremner's memorandum. It is a remarkable document, not only in respect of what it foresaw, but of the proposals it made for the avoidance of many of the difficulties and extravagances which have actually been experienced.

THE MOBILISATION OF INDUSTRY, AND IN PARTICULAR THE ENGINEERING INDUSTRY, FOR THE RAPID AND EFFICIENT FULFILMENT OF A NATIONAL DEFENCE PROGRAMME

The Elements of a Scheme

1. The Admiralty, the War Office, and the Air Ministry must each be supreme, under the Cabinet, in its own legitimate province, and must therefore be responsible for its own schemes, designs, specifications, and estimates of cost of its requirements.

2. For our purposes we need not concern ourselves with the co-ordination of the material requirements of these three War Departments in conformity with war plans adopted by the Cabinet on their collective advice.

In other words, this means that in respect of any given war plan each War Department must have the responsibility of specifying the material (ships, guns, tanks, aircraft, ammunition, &c.) it requires for its execution, and the three War Departments jointly must have the responsibility under the Cabinet of so co-ordinating their respective requirements as to constitute an effective whole.

For obvious reasons the production of munitions of war could never be allowed to come to a standstill pending the preparation of complete and final specifications of their requirements by the War Departments. In the first place, there is no such thing as finality in such a matter, and the progressive development of war plans, schemes, designs, and specifications would proceed contemporaneously with the work of fulfilling a multiplicity of requirements which had already been ascertained and agreed upon from time to time. New requirements as they came forward would therefore have to be related to earlier unsatisfied claims on the productive capacity of the country.

At every stage a Ministry of Supply would be able to function in ways not open to the three independent War Departments or to the Cabinet, and in our opinion its services would be of great value, not only to the nation, through the Government, but to the War Departments themselves.

3. A Ministry of Supply or a Ministry of Munitions, whatever name may be given to it, whilst under the direct control of the Cabinet and represented by a Minister therein, cannot be in substitution of the War Departments in respect of responsibility for their schemes, designs, specifications, and estimates of cost of their requirements. It would be a supplementary instrument of war in the hands of the nation, through the Cabinet, and by the exercise of its proper functions it should be of great assistance to the War Departments in securing the prompt and economical fulfilment of their respective requirements to the best advantage of the nation, having due regard to the vitally important matter of priorities.

4. It is probably appropriate at this point to emphasise the fact that a Ministry of Supply would include within its province of concern and control the means of production, *e.g.*, machine tools and other factory equipment, also the supply of materials, with neither of which the War Departments could or should deal in the same way, if only for the reason that the chief concern of each would be the fulfilment of its own particular requirements without regard to the needs of the others.

In other words, the Ministry of Supply would be able to relate total requirements to total supplies and total productive capacity, and as an impartial authority it could collate and present the data to instruct wise decisions in regard to priorities and programmes of production.

5. In matters of vital importance involving conflicting claims by War Departments, the Cabinet might be the superior authority on which the responsibility of decision would rest; but in many cases it might well be that, in the light of the data supplied by the Ministry of Supply, agreement could be reached between the War Departments through their representative on the War Council (presumably some such Joint Council would exist).

6. A Ministry of Supply could function only in active co-operation with industry, and as it would be impracticable to co-operate directly with thousands of individual firms, it is obvious that the chief points of contact must be the appropriate industrial federations and trade associations, which by a process of concentration through conbination of those of the same genus should be reduced for this purpose to the smallest possible number, in the interests of the expeditious and efficient transaction of business. Such expedition and efficiency would be in inverse proportion to the number of persons to be consulted and the amount of talk and correspondence involved.

7. Below the line of nodal points of contact with the Ministry there would be cumulative decentralisation by subdivisions into species and kinds, and ultimately into individual firms. But the corresponding growth in the aggregate amount of detailed work to be done would be compensated by the growth in the number of persons available to do it as decentralisation, *i.e.*, distribution, proceeded.

8. From this point onwards I shall restrict my observations and suggestions to the engineering industry, which is our particular concern and for which we have some authority to speak.

The Engineering Industry and its Place in the Scheme

9. My suggestion is that the connecting link between the Ministry of Supply and the engineering industry should be a Joint Engineering Council composed of not less than three and not more than five representatives of each of the undermentioned bodies:

(1) The Engineering and Allied Employers' National Federation.
(2) The British Engineers' Association (Inc.).
(3) The British Electrical and Allied Manufacturers' Association.
(4) The Machine Tool Trades Association.
(5) The Society of Motor Manufacturers and Traders, Ltd.
(6) The Society of British Aircraft Constructors.

The numerous other Associations representing branches or sections of the engineering trades would have to be grouped under their respective most appropriate main bodies enumerated above, which would be the channels of communication with them. If this were not done a Joint Engineering Council would be too unwieldy for quick effective action and the idea would have to be abandoned.

Each of the six above-named groups of three or five representatives would have such autonomous powers as might be necessary to enable it to act independently and quickly in matters within its special competence, without resorting to the cumbersome procedure of submitting a sectional question to a meeting of the Joint Council, but any decisions reached or action taken by one or more of the groups would be duly recorded for the information of the Joint Council.

10. It is suggested that the E. and A.E.N.F. be represented on the Engineering Joint Council for certain limited purposes outside its normal province, and that the Council, as such, should be debarred from infringing on that province of wages, hours of working, and conditions of working.

The E. and A.E.N.F. is a federation of a large number of District Associations, which would be an invaluable source of information regarding the available productive capacities of the engineering works in their respective districts at any given time, and the classes of work they are fitted to undertake. They would also be able to report to the Council any shortages of materials or other difficulties being experienced by the works in their districts.

How the Ministry of Supply and the Joint Engineering Council would Work

11. The desiderata are:

(*a*) The highest economical speed of accomplishment consistent with the required quality of performance.

(*b*) True economy, *i.e.*, the economy which takes into account not only price, but the other criteria of time, adequacy, quality, and reliability.

(*c*) The simultaneous availability of all the complementary parts of one whole, and of complete things complementary to one another for the purpose in view, so that the sterilisation of one thing by the lack of another may be avoided.

Some things Essential to the Fulfilment of the Desiderata

12.—(*a*) The speeding up of decisions by the highest authority. "A fish first goes bad at the head" (Turkish proverb).

(*b*) The speeding up of the scheming and planning to give effect to the aforesaid decisions.

The best means of achieving this is to place the responsibility in each case on a competent leader, who will be responsible for his own staff and in whom trust will be reposed, so that waste of time and money by a multitude of counsellors may be avoided.

(*c*) Promptitude in giving clear-cut orders to those responsible for getting out designs and specifications, who, as things are now, are often expected to recover time that has been needlessly lost by performing prodigies of work against time.

Good and economical designing cannot be done under the stress of extreme haste and nervous tension, except on infrequent occasions sandwiched between periods of normal working pressure.

Economy of production, *ceteris paribus*, depends in the main on scheming, planning, designing, and specifying the requirements. Given the time for skill and experience to function properly, cost of production and time of delivery may both be reduced to a minimum in the drawing office, and this is the cheapest place to do it.

Rushed drawing and subsequent alterations after the work has gone into production are a sure cause of extravagance and failure to deliver on time.

(*d*) The supply of drawings with the least possible delay after an order has been placed, or a contract has been signed.

Apart from the fact that it possibly enables a contractor to cover himself for the necessary materials, an order is not effective until the contractor is supplied with the necessary drawings and instructions to proceed, and so long as the commencement of production or construction is in suspense and its date remains uncertain he may be unable to make proper use of some part of his productive capacity on other contracts, or to enter into new commitments.

(*e*) Production in fulfilment of the really important requirements may be greatly cheapened and accelerated by the following means:—

(i) Simplication by the elimination of redundant types and variations.

(ii) The avoidance of a degree of refinement and elaboration of design uncalled for by the purpose, the conditions of use, and the short war life of the article.

(iii) Non-insistence on precision and tolerances that are not justified by the nature, purpose, and use of the article.

(iv) The restriction of the use of costly materials, the supplies of which are usually limited, to the purposes for which they are really necessary.

(v) The adoption, wherever possible, of standard commercial lines of machinery and other engineering products regularly made by British manufacturers of high repute, in preference to getting out special designs and specifications offering no real advantages. Such departures from the standard designs, specifications, patterns, and processing inevitably result in increased costs, increased prices, and later times of delivery.

(vi) The distribution of contracts in such a way, where practicable, that each contractor would have an economic volume of output of a given article instead of contracts for a variety of articles each in quantities insufficient

for really economic rapid production if only because they will not bear the cost of the expensive preparatory work, including jigs, &c., which must be spread over a large output to be a payable proposition.

SOME MEANS OF ACCELERATING THE PREPARATION OF SCHEMES AND DESIGNS

13. At any given time the available supply of skilled and experienced designers in the various branches of engineering in a single country is a finite quantity, the growth of which is a slow process, and their number is limited by the normal demand for their services. Therefore, when the demand for their services is abnormally great, either as a whole or in particular branches of engineering, the utmost care should be taken to utilise the available designing engineers and draughtsmen to the best advantage, having due regard to the fact that in the higher and more difficult classes of design their knowledge and experience is necessarily somewhat specialised. This, in fact, is an understatement of the extent to which specialisation has had to be carried in modern engineering to secure satisfactory results. For this reason it is necessary to regard designing personnel and the question of its adequacy section by section in relation to the class of designing work to be performed. The men are interchangeable only to a limited extent.

Take, for example, an electric power station—the steel structural work, the boiler plant, the steam turbines, the alternators, the transformers, the switchgear, and the instrumentation, not to mention other items, are each designed by specialists, no one of which is really qualified to do the work of any one of the others.

In these circumstances, it is suggested that as much use as possible should be made of the services of consulting engineers and their drawing office staffs by the process of delegating work to them for which they would, of course, have to be reasonably remunerated. This would not only eke out the engineering scheming and designing abilities residing in this country, but would inspire and enable consulting engineers and their technical staffs to give of their best and keep in the van of progress.

In many cases much time and money can be saved by a consultation with manufacturers for the purpose of ascertaining whether designs in their possession, with or without some modification, would be suitable for the purpose in view. Such designs would usually offer the advantage of having survived the tests of practical experience in the course of which initial defects had been discovered and rectified.

Such consultation might often with great advantage precede a decision to originate new designs, and to incur all the risks of extravagance, delay, and disappointment attending such a course.

THE FUNCTIONS OF A MINISTRY OF SUPPLY AND THE JOINT ENGINEERING COUNCIL

14. Unless the aforesaid things be done, we see little prospect of the National Defence Programme being carried out with the attainable speed and economy, and one of the chief functions of a Ministry of Supply with the assistance of a Joint Engineering Council would be to ensure that they are done.

Another of their functions would be to take care of the interests of our engineering export trade in dealing with the supply of materials, machine tools, and other factory equipment, and the allocation of personnel, required for the manufacture of goods for export. It is a matter of general agreement that the maintenance and development of our export trade is necessary to enable the nation to sustain the heavy financial burden of the National Defence Programme.

In view of the fact that the defence programme and the machinery export trade make united demands on similar materials and manufacturing capacity, and thereby give rise to important questions of economic policy and of priority, it would appear to be to the national advantage that the more important decisions, affecting the fulfilment of their respective requirements, should be made either by or on the advice of a single authority, namely, a Ministry of Supply acting with the assistance and advice of a Joint Engineering Council.

The other functions of the two bodies named have been mentioned elsewhere in this memorandum, and need not be repeated here.

Civil Engineering in 1940

No. II

(*Continued from page 7, January 3rd*)

Water Supply

A NUMBER of water supply schemes are being carried out in this country, but information regarding them might be of value to the enemy.

Information regarding the progress or lack of progress with one scheme abruptly ceased when the Channel Islands were evacuated. In Guernsey there had up to that time been work proceeding for many months on a water supply scheme, which involved the building of a concrete gravity dam known as the St. Saviour's dam. An illustrat on n last week's Supplement showed the state of the work at about the date of the evacuat on.

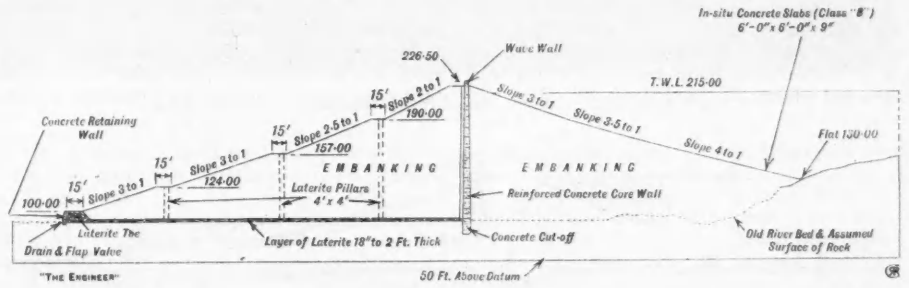
When completed, as no doubt it will be, sooner or later, this dam will create a reservoir with a capacity of 250 million gallons. It will be 860ft. long at the crest, 86ft. wide at the base and 125ft. high from the original stream bed level. According to the plans, the spillway is at a level 136ft. above O.D., and a concrete valve tower draws off the water through 15in. pipes at three different levels. The dam was being constructed in alternate blocks each 45ft. long, and arrangements had been made for recording the changes in temperature of the concrete. The engineers for this work were—presumably they still are—Messrs. T. and C. Hawksley and Mr. W. T. Halcrow, and Pauling and Co., Ltd., were the contractors.

Abroad there was brought nearly to completion a scheme for increasing the water supply of Rangoon, Burma. An engraving in last week's Supplement illustrates the downstream side of the Gyobyu dam, the chief work in this scheme, and a sectional drawing and a view on the upstream side are reproduced with this article. Work was started in 1935 under the direction of Messrs. Binnie, Deacon and Gourley, of Westminster, in conjunction with Mr. A. E. Mann, Engineer to the Corporation. The dam creates a reservoir of 16,600 million gallons capacity at a level 215ft. above O.D. In order to stand up to the effect of possible earthquakes, the dam consists of an embankment which, in view of the fact that clay suitable for puddle was not available, has an interesting flexible concrete corewall. Space is not available here to describe this wall, but reference may be made to our issue of May 31st, 1940, in which it was fully described and illustrated. A pipe line, 43½ miles long, carries the water to the Kokine service reservoir in Rangoon. It has an external diameter of 58in. and is made up of $\frac{7}{16}$in. thick steel sections lined with concrete, 25ft. long. The pipes were made by the Braithwaite Burn and Jessop Corporation and were lined with concrete by a spinning process. A contractor's railway was laid for the erection of the pipe line. At Kokine there are two float valve regulators, which were supplied by Glenfield and Kennedy, Ltd., of Kilmarnock, and which were recently described in THE ENGINEER.

GYOBYU DAM FOR RANGOON WATER SUPPLY

Work was continued by direct labour on the construction of the reservoir during the year and impounding was begun during the monsoon. The fabrication and lining at the local factory of the concrete-lined steel pipe line was completed and the laying thereof was practically finished.

In the latter half of 1939 the Government of Iraq entered into a contract with Balfour Beatty and Co., Ltd., to execute the flood relief scheme for the River Euphrates at Lake Habbaniyah, close to the town of Ramadi. The project, which was described in our issue of June 30th, 1939, consists of an inlet channel from the River Euphrates at Ramadi to allow the flood waters of the river to pass into the lake, whence the surplus overflow can be discharged through the Mujarah escape channel into the Abu Dibbis depression in the desert south of the lake. Both channels are to be controlled by masonry regulators, that at Ramadi having twelve openings of 6 m. each, and that at Mujarah eight openings of a similar width. A beginning was made in December, 1939, with the excavation of the Mujarah channel and good progress has since been made therewith. The Ramadi channel was started in April, 1940, and work was also commenced on the Mujarah regulator. There are approximately 7,000,000



SECTION OF GYOBYU DAM

cubic metres of excavation in the two channels, which is being carried out with large Bucyrus dragline excavators at Ramadi and by means of rooters, caterpillar tractors, and scrapers at Mujarah. The engineers for the works are Messrs. Coode, Wilson, Vaughan-Lee, and Gwyther.

Two new barrages at the apex of the Egyptian Delta, which had been constructed under the supervision of the consulting engineers, Messrs. Coode, Wilson, Vaughan-Lee, and Gwyther, were completed and brought into use in February, 1940, when they were used for regulating the flow of the River Nile in the Rosetta and Damietta branches of the river. These barrages take the place of the original Delta barrages, which were constructed about the year 1860–70. The contractors for the works were Macdonald Gibbs and Co. (Engineers), Ltd. The barrages were officially inaugurated by His Majesty King Farouk I in December, 1940.

In America a number of important works are under way. But we have space only to mention two. The Mono Basin scheme, the lesser known of Los Angeles efforts to obtain an increased water supply, is just due to come into service. Mono Lake is situated about 350 miles from Los Angeles at 6400ft. above sea level. Its waters, coming chiefly from springs, are too brackish to be potable. But water is taken by a diversion canal 1000ft. above the lake from creeks which feed into its western side. The water so obtained is taken along an aqueduct with a capacity of 480 cusecs to an upper branch of the Owens River, whence it eventually finds its way into service reservoirs in Los Angeles. The Mono Basin tunnel through which the aqueduct passes was the more important work. It is 59,812ft. long. The whole scheme, work upon which has been going on since 1934, will cost about 19,000,000 dollars.

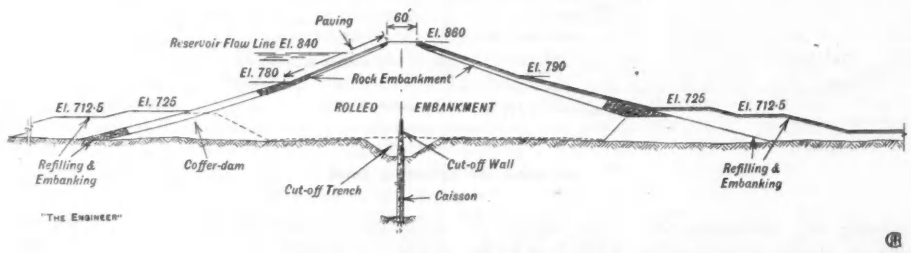
Another great American water supply scheme upon which work was proceeding very rapidly during the year is that for the Delaware aqueduct to bring eventually 700 million gallons per day to New York from the Catskill mountains. As at present authorised the project embraces the construction of three reservoirs. By the erection of the Merriman dam a reservoir will be created on Rondout Creek. A rock tunnel, 2·8 miles long, will bring to that lake the waters from the Neversink reservoir, and another tunnel, 26·5 miles long, will bring in water from the E. Delaware river. The water is to be brought to New York through a series of tunnels which are being driven from no less than thirty-one shafts. For the first 44·6 miles from Rondout reservoir the tunnel is 13·5ft. in diameter. The west branch to Kensico reservoir section has a diameter of 15ft. and the last part carrying the water to the existing Hill View reservoir in the city is to be 19·5ft. diameter.

Apart from the tunnelling work it is the construction of the Merriman dam that has the greater interest. Its cut-off wall is being formed by a number of interconnected concrete caissons sunk into a deep overburden of pervious soil. An illustration in last week's Supplement shows this work in progress and a section of the dam is reproduced on this page. The dam will have a length of 2500ft. and a height above original ground level of 200ft.

In South Africa the building of a dam across the Kromme River has been begun with the object of providing an increased water supply to Port Elizabeth. It is to be a multiple-arch dam, the first in the Union, and will create a reservoir with a capacity of 7823 million gallons, sufficient for a daily supply of 5 million gallons.

(To be continued)

PLAN AND PROFILE OF DELAWARE AQUEDUCT



SECTION THROUGH MERRIMAN DAM

The Efficiency of Locomotives*

DURING the year ended June, 1940, the mechanical condition and efficiency of locomotive stock have been well maintained. This is reflected in operating performance and may be gauged from the number of locomotive casualties and failures recorded. A casualty represents loss of time due to locomotive causes in excess of five minutes for a passenger or mixed train, and ten minutes in the case of a goods train. A failure is recorded when a locomotive requires to be changed *en route* between depôt stations. The respective figures for the years 1940 and 1930 were :

	1940.	1930.
Casualties	324	1,441
Failures	111	345
Engine miles run per casualty...	84,715	19,130
Engine miles run per failure ...	247,275	79,901

This substantial improvement has been achieved notwithstanding that the number of engines in service has progressively decreased during recent years. During the year ended June 30th, 1930, there were, on the average, 1137 locomotives counted working, as against a total of 865 for the year under review. The average mileage run per engine counted working during the latter year was 31,732, as against a total of 24,224 recorded during the year ended June 30th, 1930. This difference in average miles run per engine counted working is equivalent to an improvement of 30·9 per cent., and, when considered in conjunction with the casualty and failure figures, is an indication that intensive operation has not been inimical to locomotive efficiency.

Another evidence of the dependability and efficiency of the locomotive stock is shown in the quantity of coal consumed to meet the demands of traffic. It is customary on all railways to express the consumption of coal by the quantity burned per ton-mile hauled. For the twelve months ended June, 1930, the relative figure was 0·265 lb. per gross ton-mile, whereas during the twelve months ended June, 1940, the corresponding figure was 0·207 lb. per gross ton-mile. This is equivalent to a reduction of 21·8 per cent. in coal consumption; in other words, if coal had been consumed by locomotives during the financial year ended June, 1940, at the same rate as was actually consumed during the financial year ended June, 1930, it would have been necessary to purchase an additional 206,318 tons at a cost of approximately £148,000.

The position would have been still further improved if coal supplies had not been dislocated as a consequence of the general strike in the coal industry. During the strike it was necessary to make use of coal that had been stacked at grass, in some cases for a considerable number of years, and the quality was inferior to that used under normal conditions. Also, to augment stocks, coal of poorer quality was accepted from sources which are not usually exploited. For these reasons coal consumption and performance figures were somewhat adversely affected. During the strike no action was taken to reduce the workshop staff, it being realised that a high standard of maintenance of engines, carriages, and wagons was essential because the railways would be called upon, in consequence of war-time conditions, to handle progressively increasing tonnage.

RE-OPENING MINES.—Representations are to be made to the Mines Department on the question of re-opening copper and manganese mines in Merioneth. Some of them are owned by the Barmouth Urban Council and were worked with success during the last war.

* From the annual report, 1939–40, of the Department of Railways, New South Wales.

Naval Construction in 1940

By FRANCIS McMURTRIE, A.I.N.A.

No. II

(*Continued from page 14, January 3rd*)

United States

FOR the United States Navy an absolutely unprecedented amount of tonnage is on order. With its completion the strength of the U.S. Fleet will have been practically doubled. But owing to the necessity for lengthening existing slips and providing fresh ones, there is bound to be delay in starting the construction of the larger ships, though some may be built in dry docks.

Altogether seventeen battleships are being built, of which the first two, the "Washington" and "North Carolina," were launched in June last, while six were laid down during 1939 and 1940. It is hoped to begin the remaining nine this year.

Six of these ships belong to the "Washington" class, of 35,000 tons, with a speed of 28 knots, while the others will presumably all be of the "Iowa" type, of 45,000 tons and much higher speed, unofficially reported as 35 knots. All are to be armed alike with nine 16in. guns. It is possible that some of the ships to be laid down during 1941 will be of a still bigger design, a figure ot 52,000 tons having been stated officially as the extreme limit of displacement, owing to the necessity of all U.S. warships having to conform to the breadth of the locks in the Panama Canal.

Features of the "Washington" class include Babcock and Wilcox boilers of a new pattern, with a working pressure reported to be as high as 600 lb. to the square inch, and an exceptional degree of welding, amounting to fully 35 per cent. of the hull structure.

New York Navy Yard, which launched the "North Carolina," is to build four more battleships; Philadelphia Navy Yard, responsible for the "Washington," will undertake five more; Norfolk Navy Yard has received orders to build three; while the Newport News Shipbuilding Company, the Bethlehem Steel Company's Fore River Plant, and the New York Shipbuilding Corporation have each received a contract for a single battleship.

In addition to the "Hornet" (a 20,000-ton ship of the "Enterprise" class laid down by the Newport News Company in September, 1939), eleven more aircraft carriers of a new type, the "Essex" class, of 26,000 tons, have been ordered, the contracts being divided between the Newport News Company, the Bethlehem Company, and Norfolk Navy Yard. It is stated that they will have accommodation for 100 aircraft each. There is no doubt that the United States Navy Department was fully alive to the importance of the aircraft carrier in war, before the actions at Oran, Dakar and Taranto had made it plain to all.

Four heavy cruisers of 13,000 tons, the "Baltimore" class, are to be laid down this year by the Bethlehem Company's Fore River Plant. Orders have been placed with the same firm for four more heavy cruisers, with the New York Shipbuilding Corporation for an equal number, and with the Newport News Company for two. No indication of displacement is given in these further orders. It is reported that the "Baltimore" class will be armed with nine 8in. guns. Probably they will be enlarged and better protected editions of the "Wichita."

So-called light cruisers in hand or on order include four of the "Atlanta" class, of 6000 tons, expected to be armed with twelve 5in. dual-purpose guns, and thirteen of the "Cleveland" class, of 10,000 tons, to mount twelve or more 6in. guns. No fewer than seventeen more cruisers, which will most likely be of the latter type, have also been ordered. This work is being distributed between the New York Shipbuilding Corporation, the Bethlehem Steel Company's Fore River and Union (San Francisco) Plants, the Newport News Company and the Federal Shipbuilding Company.

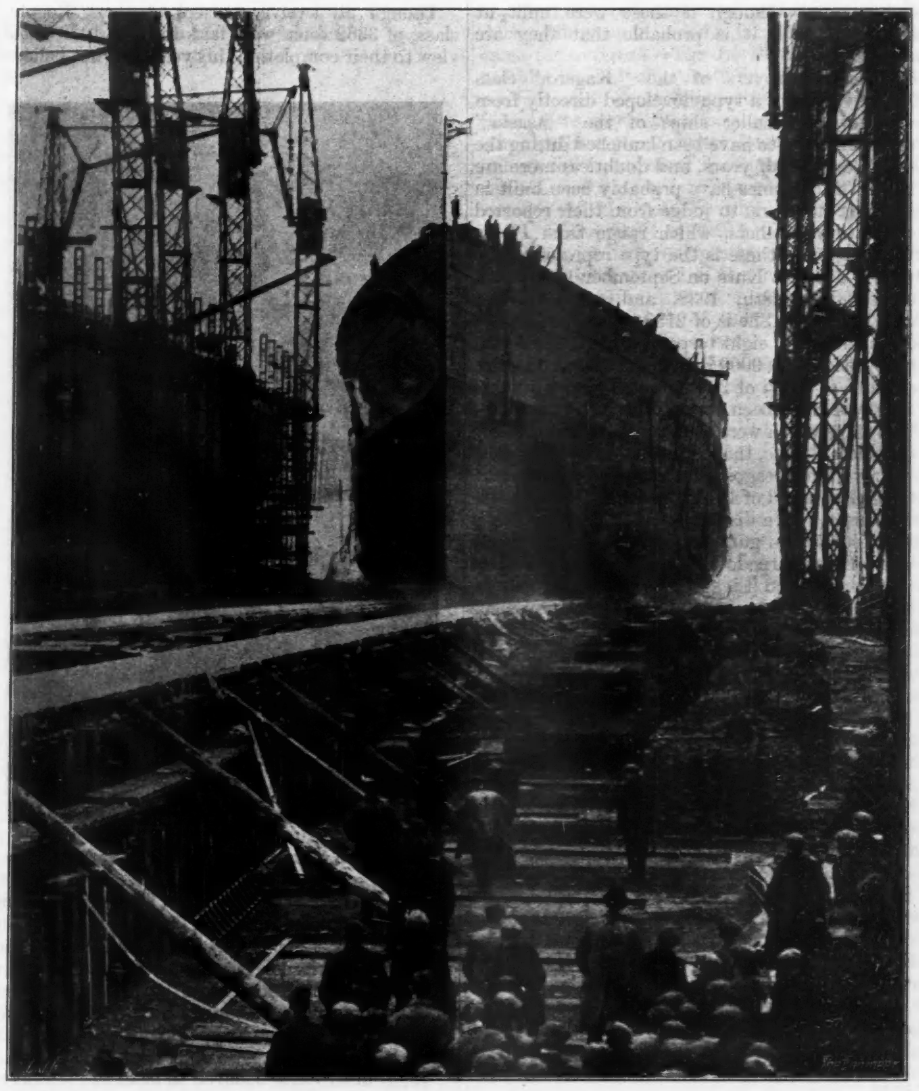
A very large number of destroyers figures in the list of new construction. Apart from the twenty-four units of the "Benson" class, about half of which should be in commission by now, more than 150 have been authorised and placed on order. Some are of 1700 tons and others of 2100 tons, the respective armaments being five and eight 5in. guns, with ten torpedo tubes. No other particulars have been received. In addition to the shipyards normally building destroyers, contracts have been placed with several new firms, such as the Seattle-Tacoma Shipbuilding Company, the Consolidated Steel Company of Orange, Texas, and the Gulf Shipbuilding Corporation, of Chickasaw, Alabama.

Submarines have been ordered with equal prodigality. Besides the eighteen vessels of the "Tambor" and "Gato" classes, nearly half of which have been launched, orders have been placed with the Electric Boat Company for forty-five additional submarines, ten of which are to be built under a sub-contract by the Manitowoc Shipbuilding Company, in Wisconsin. Six more have been ordered from Mare Island Navy Yard and fourteen from the Portsmouth (New Hampshire) Navy Yard.

It is uncertain whether all these submarines will be of the Fleet type, as exemplified by the "Gato" class, or if some will be of the small coastal design, of which two units, the "Mackerel" and "Marlin," are now nearing completion.

Many mosquito craft are being built, including twenty-five submarine chasers and a similar number of motor torpedo boats.

Apart from the long lists of purchased merchantmen and yachts, to be utilised as fleet auxiliaries, patrol vessels, &c., there are building three heavy and sixteen light aircraft tenders, which in this country would be rated as seaplane carriers; thirty-two netlayers for harbour defence; three 6000-ton minelayers; five submarine tenders of 9250 tons; and eleven minesweepers.



LAUNCH OF THE BRITISH BATTLESHIP H.M.S. "DUKE OF YORK"

Japan

Secrecy concerning the Imperial Japanese Navy has been carried to such lengths of late that a great many gaps exist in our knowledge of new warships under construction.

It is believed that at least five battleships are building or completing, including the "Nissin," launched November 30th, 1939, and the "Takamatu," which went afloat last April, the former at Kure and the latter at Yokosuka. Of the other three, one is believed to be in hand at the Mitsubishi Yard, Nagasaki, and the fourth may have been laid down at the Kawasaki Yard, in Kobe. A fifth is thought to have been begun at Kure in December, 1939, and it is possible that a sixth may since have been started at Yokosuka.

According to American information, the displacement of these ships is not far short of 45,000 tons. Other features which it is impossible to confirm are a speed of 30 knots and a main armament of nine 16in. guns.

In addition, four other large ships, the design of which appears to have been founded on the German "pocket battleship" type, are suspected to be nearly ready for sea. One of these is probably the "Kasino," launched at the Mitsubishi establishment a year ago, and another may be the "Hachijo," launched three months later, it is believed, at Sasebo. According to French accounts, the first of the class was launched at Yokosuka on June 1st, 1939, under the name "Kazekuru" or "Kadekuru"; but this name seems to have been badly mutilated and cannot be identified with any Japanese word.

No authentic information concerning these hybrid vessels is available, but a displacement of about 15,000 tons, a main armament of six 12in. guns, and side armour 6in. in thickness have been reported. Whether the Japanese naval authorities will retain their enthusiasm for this design in view of the ignominious fate of the "Admiral Graf Spee" remains to be seen.

In addition to the "Soryu" and "Hiryu," of 10,050 tons, completed during 1937–38, a third aircraft carrier of the same type, the "Koryu," is suspected to have passed into service. Two somewhat larger ships, the "Syokaku" and "Zuikaku," were launched during 1939, and it is possible that

more have been laid down since. Little is known about the two latter ships, but from their length overall (about 800ft.) it is not thought they can be less than 20,000 tons.

Very little is known of recent Japanese cruiser construction, though it is clear that the "Tone" and "Tikuma," completed in 1938–39, differ considerably from the first four ships of the "Mogami" class. Abaft the main mast the whole of the deck space is reserved for the flying-off of seaplanes, an idea probably borrowed from the Swedish "Gotland." In order to permit of this arrangement the whole of the main armament of twelve 6·1in. guns is grouped forward in four triple turrets. Though highly original, this design seems susceptible to criticism, notably the undue concentration of guns where a single heavy hit might put the lot out of action.

About five cruisers of a new design are reported to have been under construction for two or three years past, but reports vary as to their size. Probably 9000 tons is not far off the mark. The "Tugaru," which was launched at Yokosuka last June, may be one of them. So may the "Hasidate" and "Sumida," though if these were built at Osaka, as stated, it is probable that they are smaller craft.

Fourteen destroyers of the "Kagero" class 2000-ton vessels of a type developed directly from the somewhat smaller ships of the "Asasio" group, are known to have been launched during the past two and a-half years, and doubtless more are in hand. Submarines have probably been built in even larger numbers, to judge from their reported identification numbers, which range from I 9 to I 29. Biggest of these is the type represented by I 16, laid down at Kure on September 15th, 1937, launched July 28th, 1938, and completed on March 30th last. She is of 2180 tons displacement and is armed with eight torpedo tubes and a 5·5in. gun. Oil engines of 9000 B.H.P. are designed to give her a surface speed of 20 knots. How many more of this type have been begun is unknown.

Two ships which were at first reported as cruisers of considerable size, the "Kasima" and "Katori," now prove to be seagoing training ships for cadets, with the low speed of 18 knots, entirely inadequate for a cruiser. On a displacement of 5880 tons they mount four 5·5in. guns and two 5in. anti-aircraft pieces. Eight torpedo tubes are also included in the armament, and it is suspected that they may be equipped for laying mines. Otherwise there seems little excuse for building two ships of these dimensions purely for training purposes. Moreover, in several respects they appear to be expansions of the minelayer "Okinosima," of 4400 tons, launched in 1935.

Smaller minelayers continue to be turned out with frequency. In a space of two years the "Sokuten," "Sirakami," "Narifu," "Sumisu," "Kyosai," "Kunaziri" and "Isakuyi" have slipped down the ways. All are believed to be of 720 tons, with a speed of 20 knots and an armament of two 4·7in. guns.

Six ex-mercantile vessels have been adapted for service as auxiliary seaplane carriers. Four of these, the "Kagu Maru," "Kamikawa Maru," "Kinugasa Maru" and "Kinagawa Maru," are sister ships of 6800 tons gross, with a speed of 17 knots. Details of the other two, "Takyo Maru" and "Yagasa Maru," have not been published.

France

Of the many warships that were building or about to be laid down in French shipyards a year ago, few remain in existence. Though the new battleship "Richelieu," of 35,000 tons, was completed before the *débâcle*, and is now lying in a damaged state at Dakar, the "Jean Bart" has still to be finished, though removed to Casablanca before the Germans entered St. Nazaire.

A third ship of this class, the "Clemenceau," is understood to have been wrecked by high-explosive charges at Brest; and the fourth unit, the "Gascogne," does not appear to have been laid down. The aircraft carriers "Joffre" and "Painlevé," building at St. Nazaire, are believed to have been blown up on the stocks, and a similar fate probably befell the 8000-ton cruiser "De Grasse" at Lorient. Two more cruisers of this type, "Chateaurenault" and "Guichen," were to have been laid down at La Seyne and Bordeaux, respectively, but it is questionable if either will now be built.

Six incomplete destroyers of "Le Hardi" type and twelve of the "Agile" class were probably reduced to wreckage before the French Atlantic ports were occupied; but two building at La Seyne, "Le Niçois" and "Le Savoyard," may possibly be completed if the necessary material is available. Similar remarks apply to twenty submarines that were under construction in occupied territory. Four minelaying submarines were to have been built at Toulon, but only one of these is definitely known to have been begun.

Perhaps the only vessels likely to be pushed on to completion are the sloops and minesweepers that were building at La Seyne and Port de Bouc, though no positive information on the subject has been forthcoming. For a long time to come the French Navy appears likely to remain in a state of suspended animation.

Italy

No news of Italian naval construction has been received since that country joined in the war. Two 35,000-ton battleships, the "Impero" and "Roma," launched in November, 1939, and June, 1940, respectively, should be making good progress towards completion, but whether they will find any seaworthy consorts in service when they commission seems questionable.

Though all twelve cruisers of the "Regolo" class, of 3362 tons, were laid down in 1939 with a view to their completion this year, it is not believed

"LITTORIO" CLASS BATTLESHIP AT TARANTO

that they will be ready so soon. Their exceptionally powerful engines, designed to give a speed of 41 knots with 120,000 S.H.P., are likely to need an exhaustive series of trials, and the armament of eight 5·3in. guns is also novel. Up to the outbreak of war the new 8000-ton cruisers of the "Ammiraglio Costanzo Ciano" type do not appear to have been begun.

Eight destroyers, believed to be of the "Aviere" type, and four torpedo boats were authorised under the 1939 programme. Probably every effort will be made to complete these, as well as the fast *aviso* building at the Quarnaro Yard, Fiume.

Twelve of the submarines in hand last June have doubtless been passed into service, leaving sixteen more under construction. Several pictures of sunk or damaged Italian warships were reproduced in last week's Supplement.

Germany

Though Germany has undoubtedly concentrated most of her efforts on building U-boats in large numbers, she is not likely to have stopped work on the two 35,000-ton battleships launched early in 1939, the "Bismarck" and "Tirpitz." It is quite possible that the former has been completed, but the latter is believed to be fitting out still. To what extent progress is being made on the third and fourth ships of the class is conjectural.

When the "pocket battleship" "Deutschland" was officially renamed "Lutzow," the former name was said to have been assigned to an important new ship. This may have been the second aircraft carrier, the first being the "Graf Zeppelin," now probably in service.

Four 8000-ton cruisers which have been building for some time past should be ready this year, if, indeed, a couple of them have not already been commissioned. A number of new destroyers, hossibly even as many as have been sunk, may also pave joined the fleet. Undoubtedly many additional motor torpedo boats—illogically referred to as "E-boats" by the Press—have been built. Their official description is *schnellboote*, sometimes freely translated as "speed boats." The expression "E-boat" originated from the abbreviation used in signalling for "enemy boats."

Russia

Russia, like Japan, maintains a policy of secrecy in naval affairs. Discounting the exaggerated and purposely vague statements made for the benefit

"CAVOUR" CLASS BATTLESHIP AGROUND AT TARANTO

of the Russian public, there is no doubt the Soviet Navy has a good many new warships in hand.

It is asserted very definitely that the 35,000-ton battleship "Tretii International" was laid down in the Orjonikidze Shipyard at Leningrad on July 15th, 1939, but whether much progress is being made with her construction may well be doubted.

A second ship of this type is supposed to have been begun at the Nikolaiev Yard in the Black Sea, but definite confirmation of this is lacking. Similarly, the 12,000-ton aircraft carrier "Krasnoye Znamya" is said to have been started at Leningrad in 1939, and a sister ship, the "Voroshilov," in 1940.

The third and fourth cruisers of the "Kirov" class, named "Kubyshev" and "Orjonikidze," were to have been finished in 1940 or 1941, but there is no certainty that this promise has been fulfilled.

Additional destroyers of the "Leningrad" class, of 2900 tons, and of the "Stremitelni" class, of 1800 tons, are being turned out with a fair degree of regularity. Ultimately there should be fifteen "Leningrads" and thirty-six "Stremitelnis," if reports are to be trusted, but it is doubtful if more than half-a-dozen of the former and perhaps a dozen of the latter are in full commission as yet.

Sixteen of the 740-ton torpedo boats of the "Shtorm" class appear to be in service, with half-a-dozen more of a slightly improved type almost complete. Submarines are being built on a mass production system, about 170 being in a completed state according to the last reports received.

Other Navies

Of the minor navies, few are attempting much in the way of new construction, while the war hinders the booking of orders for ships or material. Argentina is building a couple of sloops in her own yards, while Brazil has in hand at Rio no fewer than nine destroyers, six of which are to replace those taken over by this country on the outbreak of war in September, 1939. Danish and Norwegian construction, though of small extent, has

presumably been commandeered by Germany. Greece was to have built two destroyers in her own dockyard at Piraeus, but it is not known whether these have been laid down yet.

Certain ships of the Royal Netherland Navy which were under construction were destroyed to prevent their falling into enemy hands, but others —notably the new cruiser "Heemskerck"—which had been launched were brought to England for completion.

Spain, having discarded some of the ships left over from the Civil War and refitted others, is now resuming the construction of the 1700-ton destroyers "Alava" and "Liniers" and of three submarines. The 1500-ton minelayers "Eolo" and "Triton" have both been launched and should be in service by now.

With the exception of the United States, Russia and Japan, the neutral country with the largest amount of tonnage under construction is undoubtedly Sweden. Progress has been slowed down on the two 8000-ton coast defence ships ordered in 1939, but four more destroyers and a number of submarines and minesweepers are being built as rapidly as possible.

The Royal Thai Navy had two cruisers on order from the Adriatico Company, Trieste, one of which is believed to have been launched, but the prospects of these ships being delivered in present circumstances are decidedly problematical.

We offer Mr. McMurtrie an apology for one of the most curious printing errors we have come across in a long experience. His article on "Naval Construction in 1940," printed in our issue of January 3rd, was stamped by an Admiralty Censor in such a way that by pure mischance the words "Capt. R.N." fell at the end of Mr. McMurtrie's name. The compositor picked them up and inserted them.—ED. THE E.

Electrical Engineering in 1940

No. II

(*Continued from page 18, January 3rd*)

Switchgear (*continued*)

ALTHOUGH war conditions are restricting development in many ways, the British Thomson Houston Company, Ltd., gave during the year considerable attention to the switchgear problems arising from modern industrial tendencies. Apart from completing new designs commenced in 1939, no fundamentally new developments were undertaken; but efforts were made to introduce substitutes for certain metals required for national purposes and to economise in the use of steel and copper. One of the new designs completed consists of 33-kV, 750 mVA, single-bus-bar, oilfilled, outdoor, metal-clad switchgear. It is designed to fulfil two conditions. The first is imposed by the restricted space available in large cities and results in a compact form of switchgear having a minimum oil content; the second condition is rather special, in that the gear is suitable for use in the open, a condition not very frequently met with, although some installations require it. The gear is of the isolated-phase type with single horizontal break oil circuit breakers, oil-immersed bus-bar and circuit isolators, and bulk-insulated armoured bus-bars. Another new design is 66-kV, 1500-mVA, double-bus-bar, oilfilled, indoor, metal-clad switchgear. This gear again illustrates a means of meeting the conditions obtaining in large cities. The design, it is claimed, is very compact for this voltage, and the space occupied in plan is small. The apparatus is of the enclosed type, with isolated phases, single vertical break, low-oil content circuit breakers, oil-immersed bus-bar selector and isolating switches, oil-immersed cable-isolating switches, and bulk-insulated armoured bus-bars. The duplicate sets of bus-bars are separated by a concrete wall 9in. thick, and the circuit breaker is separated from the bus-bars and selectors by a 9in. concrete floor. Other features of interest are the use of capacitance bushings for synchronising and potential indication, the provision of independent selector and isolating switches for the bus-bars so that the two sets of bars are not brought together at any point, and incorporation of a nine-way preselector operating mechanism for the selector, isolating, and earthing switches. This last feature enables any one of nine switching combinations to be carried out in the correct sequence, and with the necessary interlocks, by the rotation of a single handle.

Further improvements have been made to the type O H circuit breaker. The latest improvements include the provision of pneumatic operating mechanism, the incorporation of explosion chambers in the oil vessels, and the elimination of external contacts. This breaker has only $4\frac{1}{2}$ gallons of oil for ratings up to 1000 mVA at 11 kV and $10\frac{1}{2}$ gallons for ratings of 1500 mVA at 33 kV. Improvements in circuit breaker details include the introduction of contactor-type butt contacts in place of segmental contacts in the self-compensated explosion chamber. The elimination of contact wipe and the inherent throw-off of butt contacts ensure quicker contact separation, and consistent arc duration times of one to two half-cycles are now secured on this type of explosion chamber for all ratings up to 1500 mVA at 33 kV.

Preliminary designs of air-blast circuit breakers have been developed to work with complementary air-insulated switchgear for 750 mVA at 33 kV.

Another development of interest is a new spring closing mechanism for circuit breakers in which fly-wheels are provided to absorb the energy of the spring at the beginning of the stroke, and deliver it at the end of the stroke when the maximum energy is required to close the contacts against short-circuit stresses. On normal load closing, the surplus energy stored in the fly-wheel is utilised to compress the spring for the next closing operation.

Whilst production at the E.E.C. works of E.H.T. heavy-duty type gear proceeded along orthodox lines, attention was focused in particular upon the development of circuit breakers of the oil-poor and air-break types. Designs are now available for an extensive range of ratings of each of these types, the present maxima being 132 kV, 1500 mVA breaking capacity for oil-poor breakers.

Turbo-alternators

Among turbo-alternator contracts received for the home market by the British Thomson-Houston Company, Ltd., during the year 1940 were those for a 30,000-kW, 3000 r.p.m. set; a 20,000-kW set and a 15,000-kW set for British Corporations. Contracts for overseas markets included a 27,500-kW, 3000 r.p.m., 13,200-volt turbo-alternator for India. Machines commissioned during the year included a 30,000-kW, 22,000-volt, 3000 r.p.m. set, two 16,000-kW sets, and a 25,000-kW, 3600 r.p.m. set. The steam end for this last machine is a two-cylinder, double-extraction turbine designed for operation with steam at 800 lb. gauge pressure, 800 deg. Fah. total temperature, and is direct coupled to an alternator generating at 13,800 volts. Turbo-alternators in course of construction, or completed and being installed, included a 60,000-kW machine and several others of 30,000 kW or over.

Turbo-alternator developments involved a good deal of work on a new type of electrical rotor winding with improved cooling, the use of which enables the output from a given size of machine to be increased. The work of investigation and study of the properties of forgings have continued in spite of difficulties arising from war requirements, and some information on this subject has been published recently. In addition, research has been proceeding continuously on the subject of commutator ageing, brush gear, slip-rings, and allied problems. These investigations must of necessity cover a prolonged period, but considerable progress has been made towards the elimination of the minor troubles which have been experienced with these turbo-alternator details.

The English Electric Company received orders for a considerable number of turbo-alternator sets ranging in size from 600 kW, 1500 r.p.m. units for generation at 6600 volts to 30,000 kW, 3000 r.p.m. units for generation at 33,000 volts.

These contracts included a number of repeat orders and sets for installation overseas. The main development during the year was in the application of high steam pressures and temperatures and the company had in hand three large turbines for steam conditions of the order of 1200 lb. to 1300 lb. per square inch gauge and a total temperature of 900 deg. to 950 deg. Fah. In addition, four other large turbines, although for operation at a pressure of only 650 lb. per square inch, were being designed for a steam temperature of 900 deg. Fah. Research and materials testing was carried out throughout the year on suitable materials for use in these high-pressure and high-temperature turbines.

Transformers

A large number of power transformers were built by the British Thomson-Houston Company, Ltd., with shielded high-voltage windings having improved and more economical construction. These windings have been subjected to detailed investigation by means of the recurrent surge oscillograph and the million-volt, impulse test equipment, and results, the firm states, continue to show that interturn and intersection stresses are reduced to about one-third of the values encountered in unshielded windings.

Standard distribution transformers and mining transformers were improved, and orders completed during the year included a large number of duplicates for overseas. The Le Blanc 2/3 phase connection is used effectively in place of the more conventional Scott connection, particularly in those cases where transformers are to be used for straight three-phase conversion at a later date.

Furnace transformer business was particularly active, and the orders completed included the largest B.T.H. steel melting furnace unit yet made, with a rating of 8340 kVA.

Current-limiting reactors benefited by the intensive developments of the past few years. Cast-in-concrete reactors, the firm found, are mostly preferred on account of their freedom from fire risk and their low initial cost. Numerous rectifier transformers were completed, some of them being of very intricate design for special applications.

The transformer department, we are informed by C. A. Parsons and Co., Ltd., completed many orders duirng the year. Three 36,500-kVA, 11/33-kV, three-phase transformers, and two 15,000-kVA, 66/20-kV, three-phase transformers with forced oil circulation, and air-blast cooling have been completed for this country, together with a 10,000-kVA, 33/11-kV, naturally cooled transformer and two 10,000-kVA, 33/11-kV, three-phase transformers naturally cooled by means of detachable radiators mounted on the sides of the tanks.

Many groups of distribution transformers of various sizes up to 1000 kVA were completed during the year for South Africa and India, whilst two 7500-kVA banks and one 10,000-kVA bank of transformers, ratio 110/11 kV were despatched to New Zealand.

The bulk of the demand for transformers in this country, the Metrovick Company found, was for notably large transformers for power supply undertakings and medium-sized transformers for industrial purposes. Transformer orders for export showed a marked increase as regards both volume and importance. A considerable part of the export work was for large high-voltage transformers in the range from 10,000 to 60,000 kVA. Development work was carried out mainly with the following three objectives:—

(1) Effecting economy in material and labour. In this connection efforts were directed principally towards reducing weight of structural material and improvements in insulation design permitting economies in active material, while still maintaining adequate standards of strength and quality. No circumstances arose necessitating any substitution of alternative materials for those normally used in the construction of M-V. transformers.

(2) Meeting the requirements of transformers for new and special applications for the home market.

(3) Meeting new requirements of desirable orders in the export market. In this sphere, a notable development was the H.V. on-load tap changer for fully insulated transformers of service voltages up to 132 kV.

By way of illustration of improvements in design to achieve economy in material and labour a few examples may be cited.

A design for a bank of radiators, for large transformers, transportable completely assembled, was evolved. The design has been standardised to suit the limitations of rail and road transport in Great Britain. A new radiator valve was developed which, in addition to being lower in cost, is much less in depth than the standard type of gate valve previously used. A small silica gel

breather of pressed steel construction was standardised for use with small and medium-sized transformers. A new design of reversible cable sealing box was developed permitting cable entry from either above or below, without the necessity of replacing the whole or part of the casing when installing the box for reversed direction of cable entry.

An improved system of insulation design for

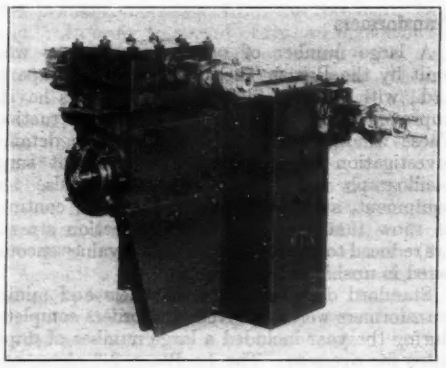


FIG. 4—THREE-POLE FUSE UNIT—METROVICK

H.V. transformers was introduced, which incorporates flanged insulating cylinders wound from thin pressboard, the cylinder and the end angle rings between the H.V. and L.V. windings being made in one piece. Tests have shown that both improvement and economy in design are achieved. A number of 110-kV transformers of this design of rating up to 10,000 kVA were under construction for the export market.

In the field of new problems in large transformer design, mention should be made of the large mobile transformer, of which the development was under way in 1939, during which year and in 1940 a number of such transformers were completed for the Central Electricity Board.

Another interesting piece of new work for the Central Electricity Board comprised two 15,000-kVA, three-phase shunt reactors for connection to the 132-kV grid for the purpose of correction of the leading power factor at times of light load on the 132-kV lines. These are the first and, it is believed, the largest reactors of their kind yet to be built. The operating conditions were considered carefully in the design, which is of the company's standard ironclad type, with "ON" cooling by means of radiators attached to the tank. The overall dimensions of each unit, as installed, are 23ft. by 14ft. by 18ft. high.

Among transformers for electric furnaces ordered a number were 6000-kVA, three-phase units for secondary 180–80 volts and 19,250 amperes. A large 33/3-kV earthing transformer was built for a municipal authority in this country, which, in addition to being suitable for carrying a fault current of 1000 amperes in the neutral, was designed to carry 250 amperes at a frequency of 540 cycles in the L.V. winding for "Ripplay" control.

In arc-suppression coils, important orders were received covering ten 84-kV coils for export, two for 1440 kVA, and eight for 1250 kVA. Another order, a 66-kV coil for the home market, had the interesting feature that the arc-suppression coil was mounted in the same tank as the 66-kV earthing transformer which provides the neutral point of the system.

A new development in colliery transformer work was the M F 3 three-pole fuse unit (Fig. 4), for service voltages up to 3300 volts. This fuse unit has been tested and certified flameproof by the Ministry of Mines, Buxton Testing Station. The fuse is used to protect a transformer giving an auxiliary supply at low or medium pressure to a haulage equipment, or other major plant controlled by an automatic circuit breaker. A set of normally closed interlocking contacts is provided to work in association with the no-volt trip coil to ensure that the main circuit is interrupted prior to the fuses being withdrawn from their housings. This fuse unit was developed for use with small three-phase transformers, where the introduction of an automatic switch is not justified. The box is of flameproof construction compound filled, and mounted directly on the side of the transformer tank. The illustration shows a fuse unit mounted on a 15-kVA, 3300-volt, three-phase transformer.

Among new special applications of transformers for which designs have been developed are transformer equipments for X-ray apparatus for hospital use, and a standard low-voltage lighting unit for lighting shelters, machine tools, &c.

Reference has already been made to development work for meeting new requirements of the export market. One such development was that of the type L.P. on-load tap changer, which is designed for operation in conjunction with transformers with fully insulated windings up to 132 kV service voltage. The whole tap changer is subject to the same high-voltage test as the transformer, viz., 265 kV for one minute (to B.S.S. 171/1936). This type of tap changer will be used for fully insulated transformers up to 220 kV.

heavy current testing transformer bank supplied to a switchgear testing company. This bank of three single-phase transformers was designed to give 250,000 kVA for two seconds at 11/2·2–1·1–

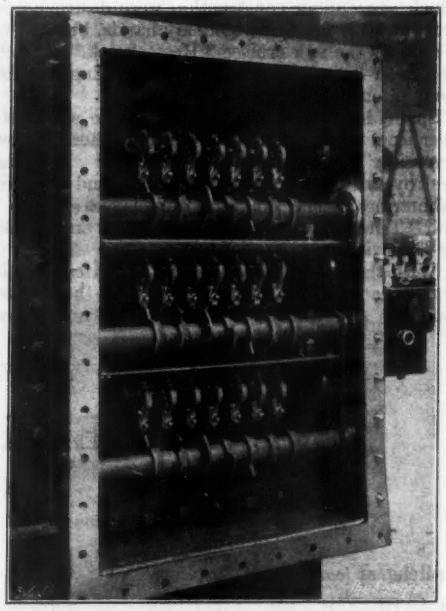


FIG. 8—CONTACTOR TYPE ON-LOAD TAP-CHANGING GEAR—FERRANTI

0·55 kV, corresponding to a maximum L.V. current of 262,000 amperes. The opportunity was taken, during a lull in low-voltage testing work, of lifting

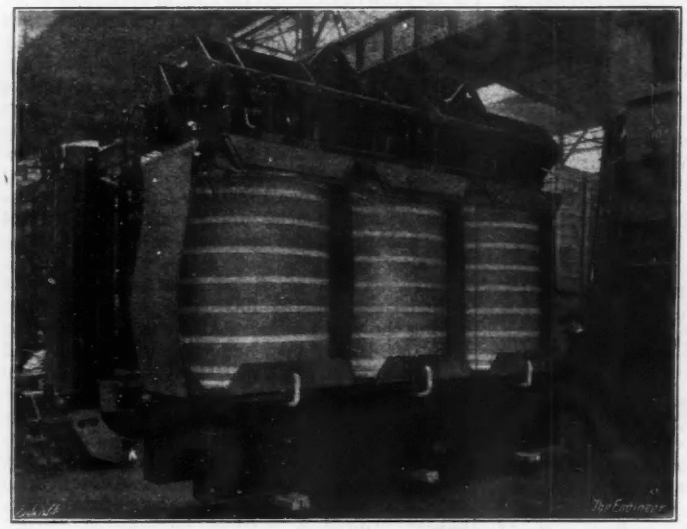


FIG. 5—87,000-KVA 11/66-KV THREE-PHASE TRANSFORMER—FERRANTI

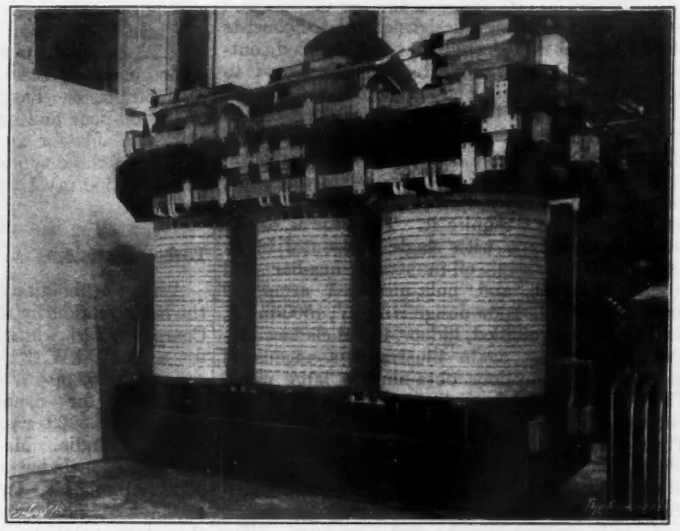


FIG. 6—40,000-KVA 32/6·9-KV THREE-PHASE TRANSFORMER—FERRANTI

An event of interest was the opening up for the first time, after four years' service, of the three transformers from their respective tanks for examination. It was found that no overhaul

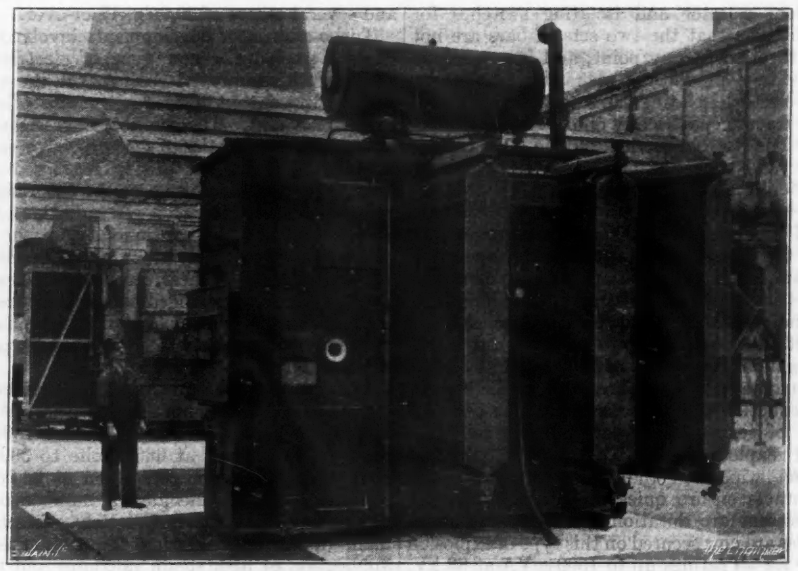


FIG. 7—33/11-KV TRANSFORMER WITH BUILT-IN ON-LOAD TAP CHANGING GEAR—B.T.H.

was necessary in spite of the fact that the windings had been repeatedly subjected to very large short-circuit forces during the four years' service. The winding clamps and screws were gone over and tightened, and it was found that only very slight shrinkage had to be taken up—in no case more than ⅛in. on the axial length of the winding. The transformers are of the shell type construction with rectangular coils.

Early in the year research and experimental work on the subject of transformer noise reached a stage which put the company in the position of being able to produce transformers with much reduced noise levels for situations where this might be considered necessary and the extra cost could be justified. Noise filter tunnels for reducing the noise emitted by fans on air-blast transformers have also been applied with satisfactory results.

Progress in the construction of large power transformers by Ferranti Ltd., is represented by two 87,000-kVA 11/66-kV, three-phase generator transformers for the extensions to a large power station (Fig. 5). These transformers are additional to five 80,000-kVA transformers of similar construction previously supplied. Two 45,000-kVA, 132-kV transformers were completed for the Central Electricity Board. Fig. 6 shows the windings of a 40,000-kVA, 32/6·9-kV, three-phase transformer recently supplied to a British Corporation. In accordance with modern practice the transformer is provided with on-load tap-changing gear for a range of 20 per cent. voltage variation,

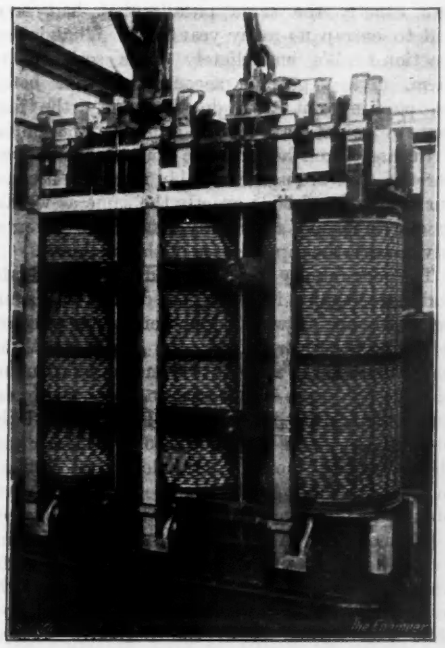


FIG. 9—10,000-KVA TRANSFORMER FOR INDIA —PEEBLES

with remote electrical control. At the full rating the transformer is cooled by means of forced oil circulation with air-blast coolers; but an alternative rating of 20,000 kVA is obtained by natural oil circulation with self-cooling. This dual rating eliminates the need for pump and fan motor operation at times of light load. The type of cooling in use is automatically controlled by the loading conditions. The low voltage for such a large kilovolt-ampere rating results in high ampere-turn concentration in the windings, with relatively large mechanical stresses. Considerable experience in the manufacture of very large transformers, such as the 87-kVA units mentioned above, and in particular the carrying out of full-scale short-circuit tests on these and similar transformers, has resulted in an extremely robust and proved mechanical construction.

The firm's output for the export market during the year was unusually large. Important orders included five 40,000-kVA, three-phase banks of 10/88-kV transformers for Victoria Falls and Transvaal Power Company, in addition to a large number of smaller units, and a 10,000-kVA bank of three-phase, three-wire transformers having voltages of 50/111/11 kV from New Zealand.

The improvement of the strength of transformer windings against lightning surges was continued. The "stress-control" method of design introduced by Ferranti, Ltd., recently was further developed and extended to cover a wider range of voltage and kilovolt-ampere ratings. The surge stresses between turns and coils are predetermined by the insulation distribution in such a manner that the same insulation provides an ample and uniform margin of electric strength in all parts of the winding. The use of the insulation actually providing the electrical strength to control the corresponding surge stresses explains the term "stress-control." The general construction of the windings follows normal practice, whilst the mechanical and thermal characteristics are unchanged. The "stress-control" design gives

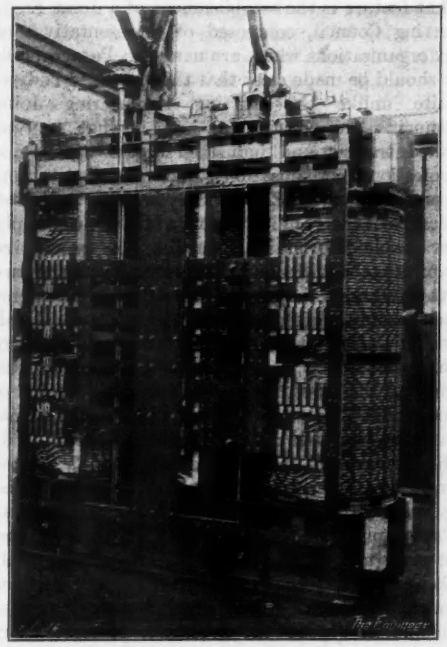


FIG. 10—TAPPING SWITCH SIDE OF 10,000-KVA TRANSFORMER—PEEBLES

increases in strength against lightning surges of two to five times normal.

On-load tap-changing gear has recently been extended to larger kilovolt-ampere ratings which are outside the range of mercury switches. The tap-change equipment employs the choke coil method of operation. Current-breaking contactors are connected to tappings on the transformer windings, and centre-tapped choke coils are connected so as to limit the circulating current

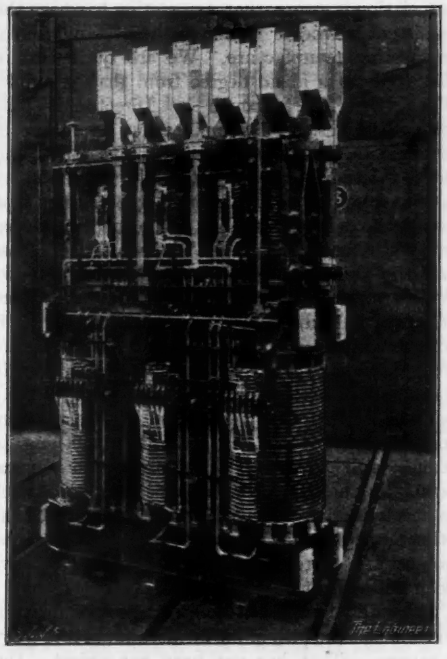


FIG. 11—750-KVA FURNACE TRANSFORMER FOR NEW ZEALAND—PEEBLES

between adjacent tappings. The drive for the tap-changing gear is provided by an induction disc motor, which enables the control gear to be reduced to a minimum, as no limit switches, brake, overload relays, time-delay relays, or auxiliary relays are necessary. The only maintenance necessary is on the contactor contacts, to which easy access is provided. All moving parts operate under oil and no periodic oiling or greasing is required, nor, owing to the simplicity of the operating and driving mechanisms, are any mechanical adjustments necessary.

Automatic operation is obtained by use of the Astatic voltage relay, which is claimed to eliminate all the objectionable features of the ordinary voltage relay, such as hold-on devices, open contacts, springs, &c., all of which necessitate skilled adjustment and attention. The Astatic voltage relay has, it is claimed, nearly 500 times the operating power of the ordinary relay, and requires no periodical maintenance or adjustment. It controls directly the induction disc motor and no auxiliary apparatus is required. Fig. 8 shows the contactor switch mechanism for this apparatus. Such simplicity has been previously achieved on small distribution units, but not, the firm states, for this range of kilovolt-ampere.

Among new transformers ordered from Bruce Peebles and Co., Ltd., were two 25,000-kVA, one 13,000-kVA, and two 5000-kVA units for the Central Electricity Board; two 15,000-kVA transformers and two 10,000-kVA "through-put" voltage-regulating transformers for Edinburgh Corporation; two 10,000-kVA and a large number of small transformers for a Scottish electricity supply company; one 10,000-kVA unit and sixty-six units in various sizes, totalling 12,500-kVA for a power supply company in England; three 10,000-kVA, four 3000-kVA, and two 1500-kVA transformers for India and a number for Canada and New Zealand.

Orders were received by the E.E.C. for transformers for service at 33 kV, 66 kV, and 132 kV, ranging in size from 3000 to 30,000 kVA units.

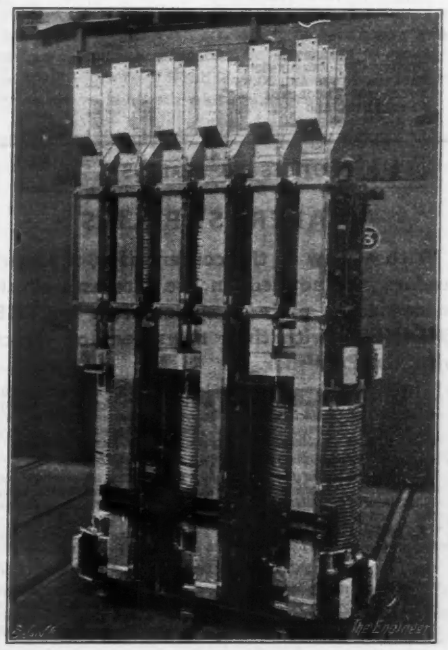


FIG. 12—L.T. SIDE OF FURNACE TRANSFORMER —PEEBLES

Most of these transformers have been provided with "English Electric" on-load, tap-changing equipment. In addition, many small transformers for 33 kV distribution were supplied for use in this country.

(To be continued)

BOOKS OF REFERENCE

Universal Directory of Railway Officials and Railway Year Book, 1940–41. London: Directory Publishing Company, Ltd. 1940. Price 20s.—This publication, now in its forty-sixth year, is one of those that are indispensable to all who take an interest in the railways of the world, and we rejoice that war conditions appear to have affected it but little. It contains, not only lists of all the railway officials in service, but many useful particulars about railways themselves, besides a quantity of statistical information and other particulars. There are three good indexes, one to countries, another a general index of railways all over the globe, and the last a personal index of railway officials.

TAR OILS AS MOTOR FUEL.—The Secretary for Petroleum announces that, in agreement with the Mines Department and the Ministry of Transport, it has been decided to introduce a scheme designed to promote the use, as fuels for commercial vehicles, of certain coal tar oils such as creosote and similar products. These will exclude light oils such as motor spirit and benzole, and heavy oils such as diesel oil which are already in use. The scheme will come into operation on January 24th, 1941, and will be subject to review after six months, and is intended to foster experimental work on these oils and their further use, with the object of effecting a saving in the consumption of imported fuel oils. Details of the scheme are to be published later.

The Engineer

JANUARY 10, 1941

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WAR AND INDUSTRY

ON another page we are permitted, by the courtesy of the British Engineers' Association, to print a memorandum written before the war by Mr. David Bremner. It is in every respect a very noteworthy document and is of particular interest at this moment when a new organisation for accelerating war production has just been announced by the Prime Minister. With remarkable acumen and foresight the writer propounded an outline scheme for a Ministry of Supply which in many respects resembles that adopted when the actual need arose. But Mr. Bremner went further. He not only dealt with the organisation of a Ministry, but he laid down certain principles which should be followed in the production of war materials. The soundness of those principles has been acknowledged by more than one Minister, and we have reasons for believing that, in some measure at least, they are being observed. It is realised that it is now too late to adopt the scheme as a whole. The changes involved would create their own difficulties and delays by upsetting some of the methods and arrangements now in operation which, as a result of costly experience, have been made to function satisfactorily. Nevertheless, we are sure that engineers will find much in it to interest them and some things worthy of consideration and practical application.

Leaving the first part of the memorandum to speak for itself, we desire to direct our readers' attention to those sections in which the desiderata for rapid and economical output are laid down, and the concluding paragraph, which discusses the "Function of a Ministry of Supply and the Joint Engineering Council." But in the first place it is necessary to note a feature of Mr. Bremner's plan, which, in our opinion, is of the first importance. That feature is the establishment of a Joint Engineering Council, composed of representatives of six organisations which are named in Paragraph 9. It should be made clear that this proposed body is quite unlike the existing Engineering Joint Council. The constituents are all what may be called trading and industrial organisations, not professional organisations, like the Institutions represented on the E.J.C. They have been selected because of their ability to give a Minister of Supply invaluable information regarding the productive capacity of factories and the classes of work they are fitted to undertake, and to deal with such problems as the supply of materials to the works which fall within their field of operation. In some measure this work is now being done by the Area Boards, but had there been in existence at the outbreak of war such a Council as that suggested in the memorandum, the task of organisation which fell upon the Ministry of Supply would have been facilitated and its realisation accelerated. With this premise let us turn for a moment to Section 12 and to Paragraph (*e*) of that Section. Here Mr. Bremner presents means by which output could be "greatly cheapened and accelerated." They may be summarised as:—Simplification and the elimination of redundant types; the avoidance of unnecessary refinements; greater tolerance as regards precision where it is not essential; restriction in the employment of costly material to those things for which a cheaper material is unsuitable; the adoption, wherever possible, of standard commercial lines of machinery; and finally the distribution of contracts so that each maker may receive, according to his class of work, an "economic volume." With the first four of these proposals we have already dealt on several occasions in these columns, but the support given by the memorandum is particularly welcome. As everyone who has attended many meetings of the British Engineers' Association is aware, that Association has been the consistent advocate of the highest standards of engineering manufacture. We are quite certain that it departs in no degree from that principle. When, therefore, through its Director it puts forward proposals for simplification, avoidance of refinements, greater tolerance in inspection, and the restriction in the use of costly materials, we may be absolutely confident that it is satisfied that even by so doing the quality of the goods produced will still remain as high as "the conditions of use and the short war life of the article" require. Whilst under the pressure of certain Ministers advances have been made in this direction, it is common knowledge that resistance to departure from the unnecessarily high standards achieved in the past still obtains in several quarters. It may be hoped that the publication of this opinion, sponsored by the B.E.A., will do something to reduce still further the opposition to general principles, the recognition of which might do much to accelerate the output of war materials. Of the other two clauses in this paragraph, it is unnecessary to say more than that they ought to have been self-evident from the start.

It would be unjust to Mr. Bremner to endeavour to condense the pith of his memorandum into a few sentences. That has not been our object. Our purpose has been to direct our readers to a memorandum which certainly deserves the closest attention. As we have said, it is now too late to graft Mr. Bremner's scheme on the scheme already in existence. But that limitation does not apply to the establishment of a Joint Engineering Council. Had such a body existed in 1939 it would, we believe, have been of the greatest service in the prosecution of the war. Equally we believe that if such a body can be set up now it will prove invaluable in the prosecution of peace. Engineers cannot hope to escape lightly from the tremendous problems that will fall upon industry as soon as an armistice is declared. They should begin to give thought to those problems without delay and, since unification of action is very desirable, there would appear to be no better method of approach than through a General Council, which would not only decide in advance on certain courses, but would be strong enough and united enough to present them with authority when the time for reorganisation came.

Experientia Docet

THE extent to which we are prepared to be influenced by the experiences of others probably depends upon our personalities and idiosyncrasies; many of us remember the words of wisdom spoken by our parents, giving us the results of years of their acquired knowledge, fashioned by the ups and downs of their own lives. We probably listened patiently, making the mental reservation that our parents belonged to another generation, one that did not appreciate the modern outlook. We thereupon went our own way, ignored their advice, and suffered accordingly, bearing the "whips and scorns of time, the oppressor's wrong, the proud man's contumely," but all the time gaining that intangible asset that is so freely spoken of as "experience." Benefiting by it, do we act accordingly? Assuredly not! In the process of time we become parents ourselves, and we notice our sons and daughters falling into exactly the same pitfalls that had been laid to entrap us many years ago. What is our reaction? We immediately speak seriously to them, give a graphic account of what befell us, pointing out with due solemnity the fact that we might have avoided much unhappiness if we had taken heed to the counsel of our own parents. We are unaccountably mortified because our young hopefuls do exactly the same as we did in our time and apparently ignore the parental advice with the same degree of thoroughness.

The community is composed of individuals, and here, again, it is suggested that the same principles are at work. Our country is at war; it has been at war before; the last war with all its vicissitudes is alive in the memories of many of us. We have the same enemy; there are many similarities between the last war and the present one, even though this one is fiercer and the adversary more unscrupulous and devilish in his methods. Much valuable information was obtained in the years of stress that lay between 1914 and 1918. As a country, are we benefiting as we should by all that happened in those fateful years? As engineers, are we fully applying the lessons taught us in that period? It is feared that the answer is in the negative. Let us examine a few typical examples, beginning with one that concerns all engineering enterprises, that of hours worked by employees. The need for intensive production is appreciated by all, but the folly of imagining that this demands a maximum number of hours of work by each individual is not apparent to all employers. Yet during the last war statistics were laboriously prepared and many records kept, so that the most effective number of hours might be determined. It was clearly proved that much of the work that failed to satisfy the scrutiny of the inspector was produced when operators were unduly weary, and in the same way breakdown of machines occurred most frequently when the machinist was nearing the end of a long shift and becoming unconsciously somewhat careless. Many a useful curve was plotted. But what has been the result? Intelligent engineers are ploughing the same furrow once more, and are again waking up to the fact that it is not a paying proposition to make working shifts excessively long. Closely allied to hours of work is the question of holidays. When Germany initiated her unprovoked attack on the Low Countries, our Government decreed that the Whitsuntide holiday should be cancelled. Whether from the point of view of total output this was a wise decision is a matter of opinion; but, at the time, everyone realised that politically and diplomatically no other course was open, and the response to the ministerial appeal was immediate and wholehearted. Whether the arrangement for the Christmas holiday was equally justified is open to question, and many influential

employers deliberately extended the period, realising that in the end there would be an aggregate gain in production. It may be remembered that it was not until well into the last year of war that the Ministry of Munitions fully appreciated the real value of rest periods, and then to its credit it not only recognised the need, but insisted on reasonable rest periods being allowed in all controlled establishments. Are we fully benefiting by our past experience? Are there not many who proudly affirm that they have not had a day's respite since the beginning of hostilities? Do they realise the utter folly of such a boast? We leave these questions for consideration. It has been justly averred that modern war is an engineer's war; on the last occasion the engineer had to cater for mass production of munitions as soon as someone in high places realised that a gunner preferred a liberal allowance of ammunition to a ration of one shell per gun per day. Plans for equipping shops with suitable plant and machines were speedily evolved, and these brought in their train many an interesting problem. Was it justifiable to install expensive turret lathes to cope with shell machining? Was the single-purpose cheap machine which was responsible for one operation only, but thereby entailed more handling, a better proposition? Two schools of thought argued the point, and as a result much valuable information was available. Has advantage been taken of the experience thus gained? A walk round the hundreds of shops engaged on mass production of munitions would seem to suggest that it has not, and that the same path has been followed as was taken a quarter of a century ago, and that if standard units are now being set up, it is as a result of what has been ascertained in recent months rather than on account of what was observed and recorded in the past.

It would be possible to go on multiplying instances, to descend from the larger issues to the trivialities of everyday life, apparently of little or no account, and yet which, if ignored, may seriously impair the national effort and efficiency. There is usually much real common sense in those Latin quotations which have stood the test of time; but in this particular one let us be honest, let us submit it to close scrutiny: *experientia docet*, but does it?

Obituary

ARTHUR TREVENEN COODE

WE regret to have to record the death, on Saturday, December 28th, of Mr. Arthur Trevenen Coode, who would have been sixty-five years of age next February. He was the eldest son of the late J. C. Coode, M. Inst. C.E., and grandson of Sir John Coode, K.C.M.G., Past-President of the Institution of Civil Engineers. His engineering pupilage was served with the late Mr. J. Mansergh, under whom he was engaged upon important works in connection with the Birmingham water supply. His practical professional career began in 1903 as assistant engineer on the Folkestone harbour works, carried out for the South-Eastern Railway Company, under the direction of Messrs. Coode, Son and Matthews. He was subsequently engaged for the same firm, in conjunction with the late Mr. Hugh T. Ker, M. Inst. C.E., investigating schemes for sewage outfall works at Plymouth and for harbours of refuge in Devon and Cornwall, and also for water supply to the Thorney Estate of the Duke of Devonshire in the Fen District.

In 1906 Mr. Coode became a partner in the firm of Messrs. Coode, Son and Matthews (now Coode, Wilson, Vaughan-Lee, and Gwyther) and was more especially responsible for his firm's advice to the Crown Agents for the Colonies in connection with harbours, docks and river works in many of the Colonies, more particularly in West Africa and in the West Indies. His professional duties also entailed personal investigations in China, Malaya, West Africa, Trinidad and elsewhere. He was also immediately responsible for his firm for a very large amount of dredging plant supplied from time to time to various Colonial Governments through the Crown Agents for the Colonies.

In 1932 and 1934 he was the British representative on two International Committees of Engineers on missions to China in connection with harbours, docks, rivers and flood relief works. In 1924 he was appointed the British representative on the International Technical Committee of the European Commission of the Danube, which appointment he held until 1938.

During the 1914–18 war Mr. Coode was in the Royal Navy with the rank of lieutenant-commander, and served in the Mediterranean and at Archangel. Mr. Coode was a genial companion, and his comparatively early death will be a great and sad loss to his numerous friends. His partners will greatly miss his valuable technical knowledge and help and his ready co-operation in all that made for the welfare of his firm.

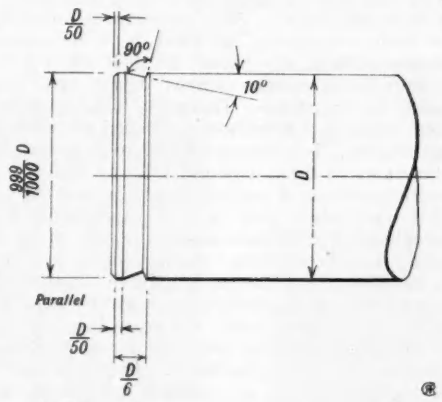
Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

LOCATING PLUGS

SIR,—After the first stages of machining the commonest way of locating components in jigs is by spigots or plugs fitting closely in holes. Location is thus effected millions of times a week, and unless accuracy is sacrificed by giving undesirably large clearances, time is lost through jamming or taking care to avoid it. This loss is preventable by a simple device. The same applies to inserting or withdrawing test bars, plug gauges, slip bushes for drill jigs, &c.

The sketch shows the end of a bar or plug shaped for easy entering into a close-fitting hole. There are several different looking ways of arriving at the same



effect, but none less trouble to make than that indicated. If it is kept in mind that jamming is related to the angle of friction, the given proportions can be suitably varied to suit different conditions—short spigots, for instance.

Anyone is free to use the device. It works like a charm. So far as I know, it has been more extensively applied at the Austin motor works than elsewhere, and I wrote there to obtain information as to its origin. The Austin Company kindly replied that Mr. F. E. Lindsay, A.M.I. Mech. E., their chief tool designer, "thought of it." He hardly looked on it as an invention, and it has been in open use for close on seventeen years. It is used also in Zeiss optical instruments.

Existing slip bushes, plugs, &c., can easily be altered and the gain thereby, particularly with unskilled labour, usually makes the change very desirable.

A. C. WHITEHEAD.

January 1st.

PROPAGANDA BY BOASTING

SIR,—In your note to my letter in your issue of December 27th you ask me "if Cort was not a greater originator than Agricola and Newcomen than Papin?" My reply is that I would not like to say. I am indebted to them all. You will, of course, remember Papin was a Frenchman and not a German.

I am glad to find you do not deny German eminence in the scientific world, though you still hold that in engineering industries "they have done much more by plagiarism than by originating." This view I hold to be quite untenable. Will you allow me to counter it by one or two references to men and things which, I am sure, have been dealt with in your columns? The other day we were all asked for field glasses. What type of field glasses? The type developed by Abbe and Zeiss. Whoever would call Abbe a plagiarist? In 1914–18 we regretted that we had had no Abbe ourselves and to-day British engineers are copying Zeiss instruments. When Crossley Brothers took up the gas engine, did they call Otto a plagiarist? Again, take that wonderful machine, the linotype—invented by whom, Mergenthaler, a Würtemburger? You have illustrated scores of regenerative furnaces, all of which have come from the invention of Friedrich Siemens. In 1883 you recorded the death of a famous engineer. His name is found in the lists of Presidents of the Institution of Mechanical Engineers, the Iron and Steel Institute, the Institution of Electrical Engineers, and the British Association. I do not know what you said of him, but in the "Proceedings" of the Institution of Civil Engineers I find remarks on "the originality of his views," "the greatness and variety of his inventions," and on "his amazing skill in the adaptation of science to industrial and useful purposes." Who was he? A German, the brother of Friedrich Siemens. And so I could go on and fill one of your issues.

War always brings boastings and belittlings, but to-day we are no more fighting German engineering than in the days of Napoleon we were fighting French chemistry and French mathematics. Twenty-three years ago, when in this country there was a tendency to decry German science, I wrote much as I am doing now, and I then quoted the lines:

> "This world is not for aye; nor 'tis not strange
> That even our loves should with our fortunes change."

After the Franco-Prussian War, Liebig, addressing the Bavarian Academy, said: "This is, perhaps, a fit opportunity for declaring, on the part of our Academy, that a hatred of race between the German and Latin nations does not exist," and also that "we cannot possibly underrate the debt of gratitude we owe to the great philosophers, mathematicians, and natural inquirers of France, who, in so many departments, have been our masters and exemplars . . ."

These were noble words, and I hope that when Hitlerism and all its evil doctrines have been utterly destroyed, some such generous remarks will be found in THE ENGINEER about German engineers, some of whom have done great service in this country, while to-day others are refugees or probably are suffering in concentration camps.

EDGAR C. SMITH,
Engineer-Captain, R.N. (Ret.).

January 3rd, 1941.

[Captain Smith's courteous letter calls for acknowledgment, but he will forgive us if we decline to enter into a volleying match with inventors as the shuttlecocks. That game, as he knows full well, can be played *ad nauseam*. It is a deuce game in which each side gets the advantage, but neither ever wins. We would ask him, however, to note that we did not assert that there were no eminent inventors in Germany, that we were careful not to claim all the great inventions for this country, and that manifestly we were more concerned with engineers than with chemists, opticians, and physicists. Furthermore, the title of the article surely gave the clue to its spirit. We still hold that by subtle propaganda Germany has succeeded in making a great many people believe that it is pre-eminent in the technical world. That propaganda has done a great deal of harm to British reputation. It ought to be countered. Science may be universal; industry certainly is not. May we leave it at that?—ED., THE E.]

ACID FROM SEAWEED.—Japan, after abandoning a first attempt to produce alginic acid made in 1923 by the Japan Smelting Company, has taken up the problem again. The acid is used as a textile sizing agent. Investigations at the Tokyo Industrial Laboratory of the Department of Commerce and Industry have led to a satisfactory process of extracting the acid from Japanese species of seaweed, and shipments to Europe and the United States have already been recently made. The Japanese industry is favoured, not only by an inexhaustible supply of various species of seaweed along several thousand miles of coastline, but by the elaborate organisation already in existence for bringing the raw material to the consuming centres. Many thousands of tons of seaweed are used annually in the production of iodine, agar agar, and edible products.

THE HONOURS LIST—AN OMISSION.—Whilst congratulating Lieut.-Colonel A. H. L. Mount on the knighthood which has been conferred upon him, we owe him an apology for the omission of his name from the list given in our issue of last week. Amongst so many names, his, by some mischance, was overlooked. Lieut.-Colonel Mount has been Chief Inspector of Railways since May, 1929, and has conducted many notable inquiries into railway accidents. For many years his work lay in India. In 1906 he was appointed Assistant Engineer on the North-Western (State) system, and between February, 1911, and February, 1912, was Assistant Engineer in charge of the Delhi Durbar light railways. He returned to his military duties for the Great War and for his services in the field was made a C.B.E. The wonderful report of the Indian "Pacific" Locomotive Committee, of which he was Chairman—see THE ENGINEER, July 7th, 21st, 28th, August 4th, 11th, 18th and 25th, and September 1st, 1939, will be still fresh in the minds of many of our readers.

Other Factors of Economic Production

By RONALD L. TANDY, A.M.I. Mech. E., Int. A.M.I.P.E.

MR. J. B. SAMSON, in his recent article "Some Factors of Economic Production," outlined the more orthodox and academic principles for obtaining increased output; but there are other means which may have more far-reaching results. System, to a point, is essential, but, as many engineers are painfully aware, the creators of systems are not fully into their stride when this point is reached, and, feeling they have not fully justified themselves, proceed to evolve further schemes which, by reason of their inflexibility, seriously retard production. The only reaction to such schemes is that operators and executives alike regard themselves as automatons—slaves of the system. The success or failure of any enterprise does not depend upon a set of hard and fast rules, but upon the skill of all employees in resorting to subterfuge and individual devices to overcome the unforeseen and unscheduled difficulties which inevitably arise in any organisation. To feel that no matter what happens the system is always right destroys the inventive urge and pride in responsibility that is the life blood of those upon whom production depends. We are faced to-day with an unusual situation that cannot be met with orthodox methods.

Distribution of Vital Information

The writer does not by any means wish to imply by the foregoing that unbridled departure from the specified procedure should go unchecked, as this would transfer control from its appointed seat to hordes of minor executives and the result would be chaos. There have been far too many instances in which an entire production programme has been wrecked owing to foremen and others departing from the specified operation sequence, ignoring datum faces, passing work outside drawing limits, and other reasons too numerous to detail. More to the point is to insist upon, and provide, the necessary machinery for suggestions to be conveyed to a department competent expeditiously to investigate their ultimate result and productive value.

The modern tendency to subdivide operations has resulted in a somewhat restricted outlook of those in control of each department as they are concerned solely with the conditions and circumstances obtaining in their own particular shop. It is therefore essential that before any predetermined procedure be altered, the full effect upon the whole production unit is diligently explored.

Production has often received a far greater fillip from accidental discoveries than from weeks of methodical development, and it is often found that a suggestion offered as a solution to one problem, although impracticable for that particular case, has provided a means of overcoming other problems that have been baffling engineers for a considerable time. It is for this reason that the provision of some means by which problems and their solutions are circularised to departmental officials is strongly advocated. This could take the form of a bulletin issued as circumstances arise in which solved and unsolved problems were fully set out. It is in this connection that the technical Press does so much good. How much more helpful it would be in a community whose interests are relative. This same means could be used to notify the entire works of any changes in procedure in any particular department, as this often necessitates alterations in other departments that are difficult to visualise by the instigator of the alteration. Such a bulletin would eventually displace the cumbrous system of departmental notes, notification of alterations, and other communications which are usually completely ignored. Circumstances have often indicated the need for what may be termed a "contact engineer." No matter how democratic an organisation may be, there is invariably a distinct line of demarcation between the drawing, production and planning offices, and the shops which tends to obstruct a free and friendly interchange of information. The control side may, in all good faith, insist upon a certain thing being done in a certain way, firmly believing that no other means would achieve the desired results, whereas the man in the shop, by reason of his essentially intimate contact with working conditions, may be in a position to suggest an alternative which would increase output and cheapen production. On the other hand, it is sometimes important that the specified procedure be strictly followed even when a much easier and more simple way of doing the job would appear to the man in the shop to produce the same results. This condition breeds a feeling of antagonism which could easily be swept away by a lucid explanation.

A contact engineer with a roving commission, being a man able to take a comprehensive view of the complete manufacturing process, could do much to increase production and would, furthermore, foster a spirit of co-operation that is so sadly lacking in many plants to-day.

Manufacturing Tolerances

The subject of manufacturing tolerances is the cause of much controversy which generally results in friction between the planning and production departments. This state of affairs will persist until steps are taken to acquaint both sides with the difficulties which arise both in production and planning, and here again valuable work could be done by the aforementioned contact engineer.

The magnitude of manufacturing tolerances is governed by many factors which may not be common to all cases. No tolerances can be fixed satisfactorily unless the whole sequence is considered, as even apparently unimportant dimensions may have a marked effect upon the accuracy of the finished article. Should tolerances, especially for early operations, be fixed in a haphazard manner without due regard to their effect upon subsequent operations serious delays and poor results are inevitable. There are, however, many cases where fine tolerances are called for without justification. It is ridiculous to show on a drawing a tolerance of three-thousandths of an inch where ten-thousandths of an inch would be permissible. This observation may appear superfluous, but draughtsmen as a class are notoriously prone to insist upon conditions which are unnecessary to the efficiency of the part produced. The writer is aware of many instances in which time and money have been wasted for years in producing unwarranted accuracy owing to a draughtsman's ignorance of shop conditions. If production is to be increased to an absolute maximum, the first step is to examine all drawings of finished components for these conditions; the result will be astounding.

Mr. Samson touched upon the measurement of surface finish, but we must not be too enthusiastic on this point at the present time. There is a growing tendency to specify an ultra finish on many parts where a good ground finish would be as good, if not infinitely better. Too much value is often placed upon finish at the expense of accuracy. The quality of the turned finish on parts that are to be subsequently hardened and ground is of far more importance from a production point of view. The better the finish produced by turning the less will be the grinding allowance required to clean up the surface after heat treatment. Standard measuring tools such as plug and snap gauges measure the high points or crests of the ridges produced by turning, whereas it is the amount of material available between the roots of these ridges which determines whether a surface will clean up. It is advisable, in all cases, to investigate the cost of producing a good turned finish as compared with grinding away metal in excess of a predetermined minimum. Although the maximum permissible tolerance should appear on the process sheet for every dimension even if it be as much as plus or minus $\frac{1}{8}$in., some check should be made on the turned dimensions of parts which are to be subsequently ground. It is sometimes found that operators, anxious not to produce work undersize on external diameters and oversize on internal diameters, keep well and easily to the "safe" end of the tolerance. The writer has known cases where a tolerance of six-thousandths of an inch has been allowed, but on subjecting a lengthy run to 100 per cent. inspection it was found that the maximum variation was three-thousandths of an inch. As the "safe" end of a tolerance leaves the maximum amount of material to grind away, the tolerance was reduced, the minimum grinding allowance remaining unchanged. The effect of coarse turning tolerances on grinding times can be very marked, particularly where automatic machines, such as continuous surface grinders or centreless grinders, are employed through which the work must pass several times before the required size is obtained. For example, consider the grinding of a batch of rings on a centre grinder, the turning size being $+\frac{0{\cdot}018\text{in.}}{0{\cdot}010\text{in.}}$ above finish ground size. If the amount of stock removed per pass is 0·002in. it is obvious that rings turned to the upper limit must pass through the machine four times before the work turned to the lower limit is touched by the grinding wheel. As the turning tolerance is reduced, the number of ineffectual passes is reduced.

The Prevention of Spoiled Work

At the present time, especially since the introduction of diluted labour, the prevention of scrap is of paramount importance.

One of the principal causes of rejected work is incorrect grinding allowances for heat-treated components. The allowances required to permit of a surface being cleaned up by grinding vary with the section of the part, the material, the skill of the hardener, the condition of the machines used for previous operations, and other factors. When any one set of conditions is thoroughly understood it is possible to estimate with a considerable degree of success the allowance required on a component after visual inspection, but to draw up a scale of allowances and apply it indiscriminately is to court disaster.

The variation of parts as a result of heat treatment is the cause of more work being discarded because it cannot be cleaned up to size than any other factor, since equal distortion on different batches of the same components is seldom experienced. The hardener should be consulted wherever pieces of unusual section are encountered, as he alone can decide such matters as the period of soaking, the method of quenching, the question of supports, both in the furnace and during quenching, and the probability of rehardening being necessary. Not only must expansion or contraction be considered, but also oxidation and the tendency for parts to become out of round. It is impossible on some parts, notably with long, thin sections, to make an allowance for correcting any bending that may occur, despite all precautions, during heat treatment, and, if the material permits, a straightening operation should be introduced prior to grinding. The majority of spoiled work is not due to errors, but to sheer carelessness. Familiarity undoubtedly breeds contempt, and it is not unusual for an operator who has been producing good work for a considerable period suddenly to create an appreciable amount of scrap. This may be due to apathy and a change of occupation is indicated.

Contrary to accepted ideas, it is advantageous to all concerned to move operators at intervals which depend upon the nature of the work and the character of the operator. This prevents the feeling that the work being done is insignificant and is therefore beneath the intelligence of the operator. Among the more general causes of scrap are incorrectly marked gauges, indecipherable drawings, the lack of any system in the method of expressing information on drawings, jigs which are not foolproof, gauges with which it is impossible to measure correctly, and too enthusiastic ratefixers. There are many means whereby the percentage of spoiled work may be reduced, some ingenious, some useless. The two most effective means encountered by the writer are the payment of a bonus to those sections with the lowest percentage of scrap and a display case showing scrapped work and its cause.

With the bonus system great skill and tact is required, and a method of handicapping is necessary. Some sections may inevitably produce a higher percentage of spoiled work than others by reason of the nature of the work in that section. The most satisfactory means would appear to be the display case. Samples of the scrapped parts are shown accompanied by a card bearing full details of the cause, the section responsible, the quantity, and value. It is usual to exhibit a chart, which may cover the entire factory or be subdivided into sections, from which the man in the shop can see at a glance the fluctuations of the scrap percentage from week to week.

In conclusion, I would appeal to all, particularly during the present emergency, to spare no pains to obtain a better spirit of co-operation between all departments, putting aside personal feuds and prejudices, and to work together—as engineers—worthy of our forbears.

Farm Implement Control

IN our issue of July 7th, 1939, we described the new British tractor which was exhibited for the first time at the Centenary Show of the Royal Agricultural Society, held at Windsor. The tractor was specially designed to deal with hauled implements and with implements designed on the unit principle. Ample power was provided for hillside working and for hauling an 8ft. binder. Provision was also made for a road haulage speed of 20 m.p.h. Ease of implement

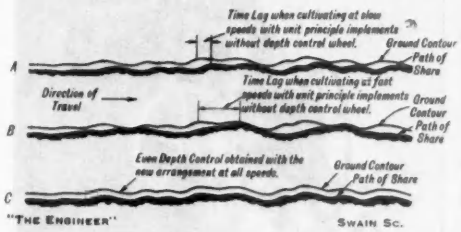

Time Lag when cultivating at slow speeds with unit principle implements without depth control wheel.
Ground Contour
Path of Share
A
Direction of Travel
Time Lag when cultivating at fast speeds with unit principle implements without depth control wheel.
Ground Contour
Path of Share
B
Even Depth Control obtained with the new arrangement at all speeds.
Ground Contour
Path of Share
C
"THE ENGINEER"
SWAIN SC.

FIG. 1—DEPTH CONTROL EFFECTS

attachment was fully considered, and the draw-bar attachment was so arranged that either a simple draw-bar of geometrical design could be used or hydraulic control fitted. The excellent reception which the new tractor has received, together with the acceleration of tractor production associated with war-time needs, has delayed the development of the hydraulic principle and its operating unit, but that development has not been overlooked. Several pilot sets have been at work in all parts of the country, often under gruelling test conditions, especially as the parched land of last summer made the operating conditions unduly severe.

Now that limited supplies of this unit are possible, it is felt by David Brown Tractors, Ltd., of Huddersfield, that the time has arrived for the introduction of the "David Brown" unit principle of implement control and the range of implements accompanying it, which are now equipped with an entirely new and patented method of depth control. The unit principle idea of carrying and supporting the implement on the tractor is not new, and has been the subject of more than thirty patents since it was first introduced about thirty years ago. One of the main objects sought has been to achieve a line of draught that is nearer the horizontal than that which can be obtained with a hauled implement, thereby minimising the tendency for either the implement to pull the wheels into the ground or for the tractor to pull the implement out of the ground. One disadvantage of many of the designs has been the see-saw effect which obtains with a rigid structure, whereby when the front wheels drop into a hollow the implement rises, and *vice versâ*. That tendency was kept as low as possible by close coupling the implements and tractor, but even then the results were not satisfactory. A serious attempt was made to get over this trouble in the "Ferguson" machine, which was made for some years in this country by the company which has since been renamed David Brown Tractors, Ltd. That design marked a considerable step forward, as the implements were flexibly mounted and the hydraulic control was arranged so that when the front wheels dipped a valve was automatically operated and the implement also lowered. The machine did excellent work and substantiated the claims made for it, but experience on all types of land showed certain definite shortcomings, which have led to very substantial changes and developments. While the automatic depth control functioned satisfactorily, it was found that the time lag between the tractor dipping and the compensating movement of the implement had the effect of reproducing the undulations of the surface by similar irregularities at the bottom of the furrows; but at a difference in spacing, equal to the distance the tractor had travelled while the dashpot arrangement of the hydraulic mechanism was operating. The effect of this action is shown somewhat exaggerated in the line A in Fig. 1, and it will be noted that the disadvantage has been kept within fairly reasonable bounds by the use of a speed which is comparable with that obtaining with horse-drawn implements. The line B, also shown in Fig. 1, shows the type of result which is obtained when travelling at a speed which should be quite reasonable with a tractor if one is to get the full benefit of mechanisation. In actual experience it was found possible with certain speeds and conditions to obtain results which suggested either that the compensating device was not working or even that it was working the wrong way. The explanation was not readily apparent, but when ultimately realised it was very simple, namely, that the mechanism was functioning perfectly, but it was functioning late. Such a condition was, of course, sometimes exaggerated by the varying ground resistance and suction, &c., but it was realised that to be a success all conditions must be allowed for. It was also found that it was difficult to do satisfactory work when operating on light soil and particularly so on shallow work, such as weeding. This was easy to understand, as the operation of the hydraulic mechanism depended entirely on the resistance of the land, which was, of course, the same as the draw-bar pull being exerted by the tractor, and where this was negligibly small the automatic depth control was non-existent. Another defect which this earlier type attempted to combat was the falling away on sidling ground, and

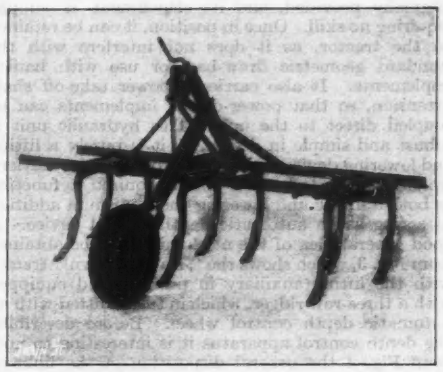


FIG. 6—CULTIVATOR AND DEPTH CONTROL WHEEL

FIG 2—TRACTOR WITH HYDRAULIC CONTROL UNIT

FIG. 3—TRACTOR WITH THREE-ROW RIDGER AND DEPTH CONTROL WHEEL

FIG. 4—TRACTOR WITH PLOUGH AND DEPTH CONTROL WHEEL

FIG. 5—TRACTOR WITH SPLIT DEPTH CONTROL WHEEL

this was done by means of a fin on certain implements, but as this was also dependent on soil resistance, it was found to be inefficient on shallow work. The elimination of these defects has been the subject of long and intensive research and, as frequently is the case with these problems, the solution was surprising in its simplicity.

The new hydraulic unit, which is illustrated in Fig. 2, is a self-contained auxiliary which can be bolted on to the rear axle in place of the cover originally provided, and its attachment is simple, requiring no skill. Once in position, it can be retained on the tractor, as it does not interfere with the standard geometric draw-bar for use with hauled implements. It also carries a power take-off shaft extension, so that power-driven implements can be coupled direct to the unit. This hydraulic unit is robust and simple in design, as it is purely a lifting and lowering device and has none of the complications which is entailed when the unit is required to function as both a lifting and lowering mechanism in addition to acting as an automatic depth control device. A good general idea of the mechanism can be obtained from Fig. 3, which shows the " David Brown " tractor with the lifting auxiliary in position and equipped with a three-row ridger, which in turn is fitted with an automatic depth control wheel. Before describing the depth control apparatus it is interesting to note from Fig. 4 the general disposition of the linkage, which can best be described as a rhomboidal hitch, as the support follows the simple geometric principle and definitely obviates any tendency for the implement to dip laterally. In a transverse direction the levelling lever controls the level of the implement to suit the contour of the ground.

The depth control wheel—see Fig. 3—with its method of mounting and contact forms the basis of the positive depth control and as compared with previous elaborate devices, such as inaccessible and intricate pumps, &c., built into the body of the tractor, is very simple in its design. If a 6in. depth of cut is needed it is only necessary to set the wheel accordingly and it maintains the setting. With the exception of splitting ridges, this standard pneumatic-tyred control wheel can be used for cultivation work with unit principle implements.

The operation of ridge splitting has been the subject of extensive research, which has resulted in the production of the split depth control wheel, which conforms to the angle of the original ridging. This precludes the usual tendency for the implement to wander and gives a degree of automatic control otherwise impossible. The wheel can be fitted in several minutes and requires no adjustment beyond the depth setting, as in the case of the pneumatic wheel. It is shown in Fig. 5. It will be seen that the lifting and lowering lever, the depth control handle and the levelling lever are still within comfortable reach of the driver's right hand.

In the earlier unit principle machines experience showed that breakages were frequently caused by material fatigue owing to the tractor being driven rapidly over rough fields and roads with the implements lifted. It will be readily appreciated that the vibration of the overhung implement sets up very severe stresses. With the new device the depth control wheel also supports the implement and entirely eliminates the risk of damage. A further feature of the depth control wheel is that it can be changed from one implement to another in a few seconds.

Other implements include a spring tine cultivator, which can be conveniently operated in small fields and small headlands. It is illustrated in Fig. 6.

Those experts who have seen these new unit principle implements at work have, we learn, expressed their enthusiasm regarding their value to the nation in increasing food production. It is unfortunate, perhaps, the makers state, that there will be some delay in supplying all the demands, as it has been realised that nothing less than complete tooling and mass production will enable the firm to even touch the fringe of the demands, while it is impossible to allow anything to interfere in the slightest with the production of the tractors which are so badly needed. The makers are in a position to fulfill orders in strict rotation, and purchasers may rely on the manufacturers giving them the earliest delivery that the emergencies of the present-day circumstances permit.

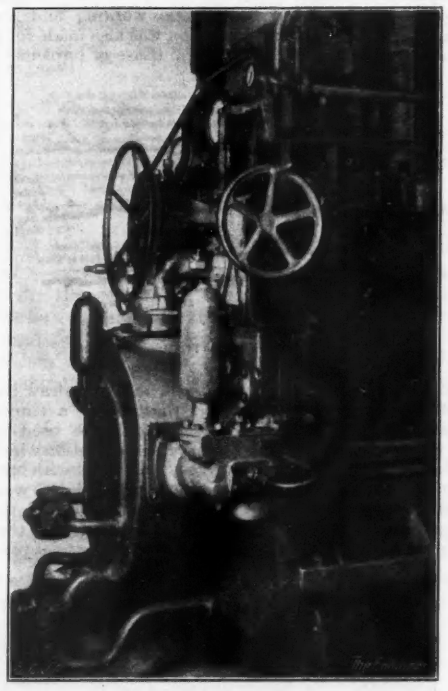


FIG. 2—CONTROL WHEELS AND PUMPS

540 B.H.P. Marine Oil Engine

IN an article which appeared in our issue of October 27th, 1939, we described and illustrated a new design of Mirrlees oil engine that was to have been exhibited on the stand Mirrlees, Bickerton and Day, Ltd., of Hazel Grove, Stockport, had taken at the Olympia Engineering Exhibition, which was cancelled on account of the outbreak of war. The engine was a four-stroke unit of the latest " HF 6 " type, which was to have been shown with a Büchi exhaust gas-driven turbo-supercharger. The engine had cylinders with a bore of 13¾in. and a stroke of 21in., and its designed output when supercharged was 1080 B.H.P. at 430 r.p.m.

THE NEW MARINE DESIGN

In the present article we deal with the marine version of this engine, which has been developed by utilising the cylinder heads, valve operating gear and running gear of the industrial engine we have referred to, with the bilge pump and water pump and the air compressor end of the marine engines previously built by the firm. In previous marine engines of Mirrlees design a reversing system was adopted, in which, when running astern, the air valve became the exhaust valve, a principle with the advantage that only one cam was needed for operating each valve. In the new design we are describing, however, each valve maintains its function for both ahead and astern running, thereby requiring two cams per valve, one for running ahead and the other for running astern. The reason for the departure from the usual Mirrlees reversing system was to enable marine engines to be supplied with turbo-supercharging, which was not possible with the earlier reversing system. Several engines built by the firm have been supplied for industrial service fitted with turbo-supercharging, and it has been recognised that the system gives an improved economy, with a reduction in weight and space taken up. It also increases the range of power which can be covered by a series of engines having a given bore and stroke. It is the intention of the firm to manufacture the new marine engine in three units with six, seven and eight cylinders, having a rated output of 90 B.H.P. when running at a speed of 300 r.p.m. and operating with normal atmospheric induction. When supercharged the same cylinder has an output of 135 B.H.P. at the same speed, and proportional powers at lower speeds. The new series of engines, therefore, covers from 400 B.H.P. at 250 r.p.m. with six cylinders unsupercharged to 1080 B.H.P. in eight cylinders supercharged.

DESIGN AND CONSTRUCTION

In the accompanying engraving, Fig. 1, we show the six-cylinder unsupercharged engine with a designed output of 540 B.H.P. at 300 r.p.m., the cylinder bore being 13¾in. and the stroke 21in. As will be apparent from the sectional drawing of the engine, Fig. 4, the design incorporates separate cylinders, fitted on the top of a crank case column. Such an arrangement has considerable advantages over monobloc cylinder construction, in that, in the event of a cylinder becoming accidentally fractured, it can be readily replaced, whereas a similar crack in a monobloc column would entail the replacement of a major part of the engine. Separate cylinder liners are fitted into the cylinders. The cylinder heads, it may be noted, are deep and they have eight bolts, which permit the cylinder head joint to be tightened uniformly. The air and exhaust valves are readily removable, and the air and exhaust passages are cast into the cylinder head on opposite sides, an arrangement which gives a simple and reliable lay-out of the air and exhaust manifolds. The air manifold is at the front of the engine, while the manifold for the exhaust gases is at the back of the engine. Particular care was taken in getting out the design to provide for effective cooling. From the cylinders the cooling water is passed to the cylinder heads through two external connections. It is then led to the centre of the head and is injected at the

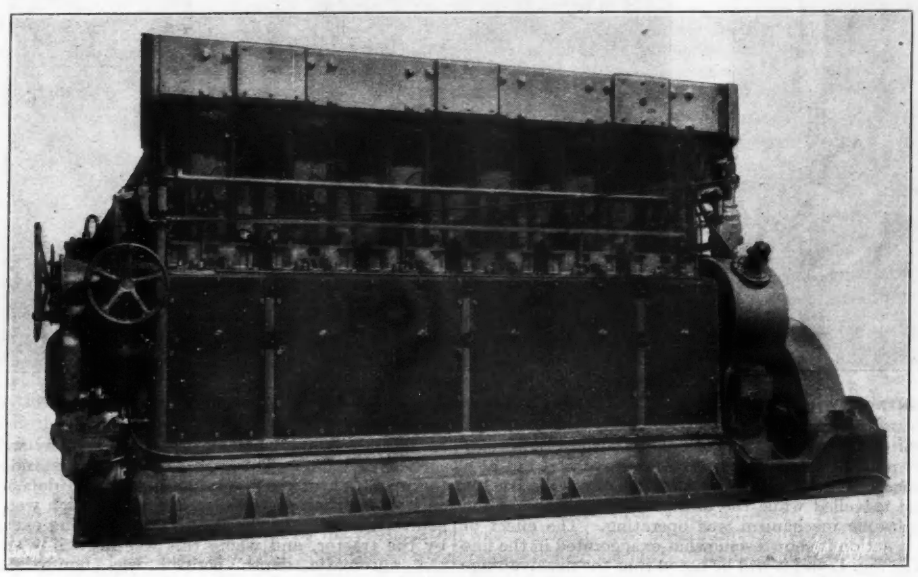


FIG. 1—SIX-CYLINDER MARINE OIL ENGINE

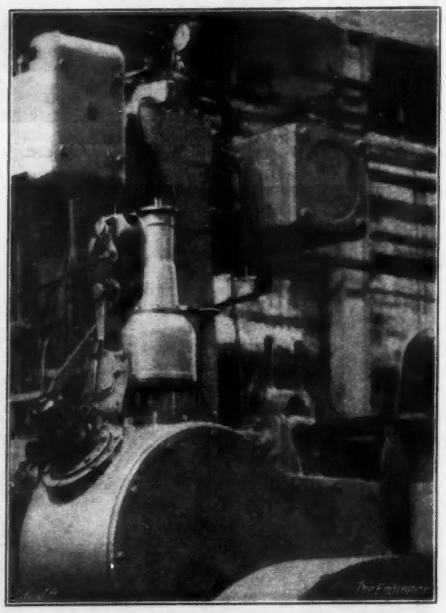


FIG. 3—GOVERNOR END

hottest part of the injection nozzle housing. The starting of the engine is ensured by an ample supply of compressed air. There are two main starting receivers, each having a capacity of 22 cubic feet, which are sufficient to manœuvre the engine thirty times. In addition, there is a small receiver with a capacity of 5 cubic feet, which can be quickly charged for getting the engine away in an emergency hould the main supply of air have inadvertently become depleted.

The engine operates on the airless injection principle and is fitted with Bosch fuel pumps and injectors. It is totally enclosed with forced lubrication to all the working parts. The cylinder heads and valve gear of the engine we illustrate were left open for easy accessibility in the engine-room of a ship, though they can be covered by hinged sheet covers to give total enclosure similar to the standard Mirrlees stationary engine. The engine drives its own bilge, water pump and two-stage air compressor from an overhung crank at the forward end of the crankshaft and double crank. Both the bilge and water pumps are interconnected so that either pump can do the duty of circulating water round the engine and the two-stage air compressor is provided with an intercooler between the stages and is automatically controlled so that it cuts out when the air receivers reach a pressure of 350 lb. per square inch, and begins to pump when the pressure falls to 250 lb. per square inch.

THE LUBRICATING OIL SYSTEM

The lubricating oil system is of the dry sump type and one of the double-acting plunger pumps takes the oil from the engine bed and delivers it to the oil tank situated on the bulkhead, the other taking the oil from the tank and delivering it under pressure to the engine. The pumps are cross-connected, so that either pump can be used for either duty, and in the case of a breakdown of either pump the other can operate the engine on a wet sump system drawing the oil from the engine bed and delivering it under pressure to the bearings. The two lubricating pumps are driven from the

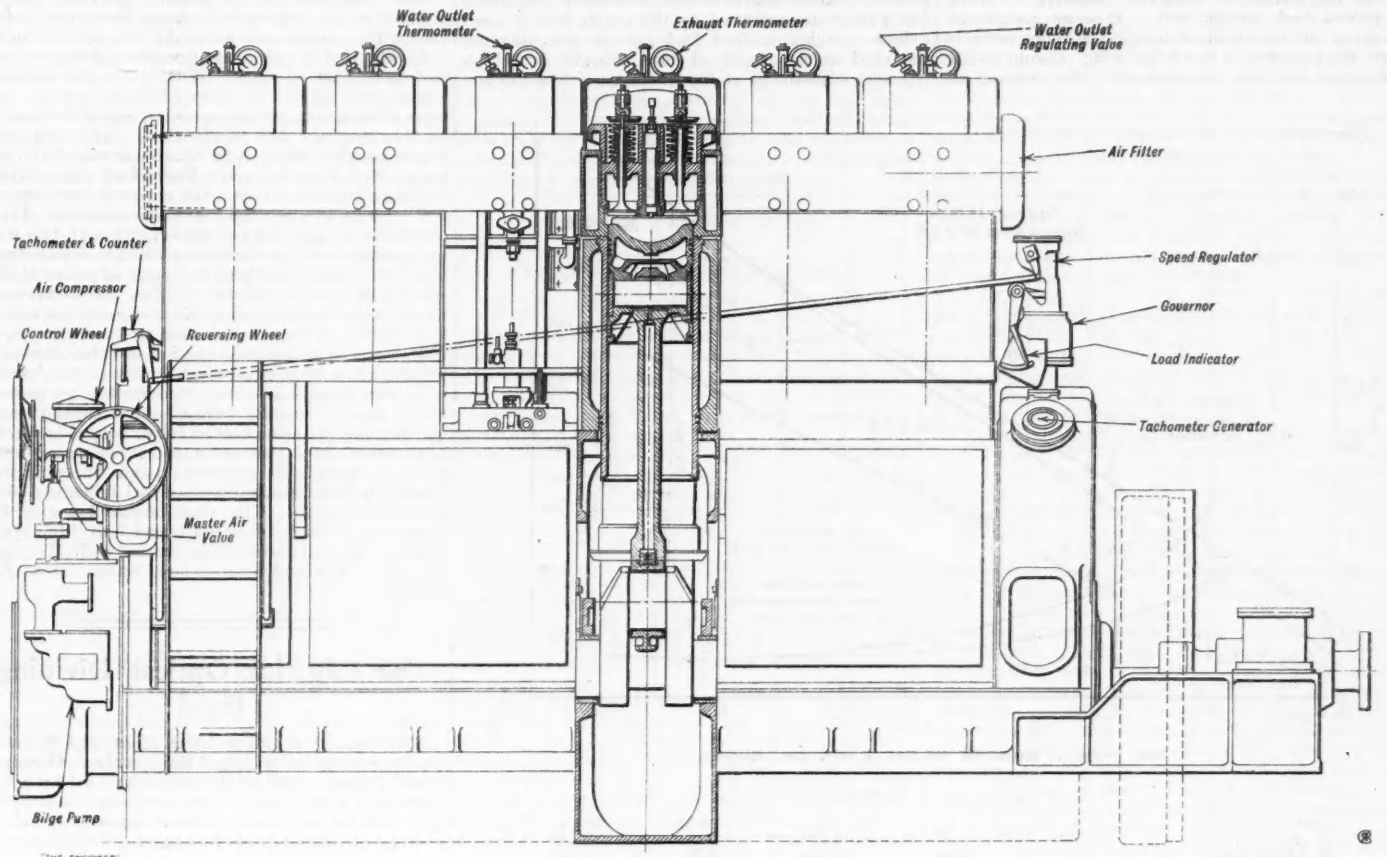


FIG. 4—PART SECTIONAL ARRANGEMENT OF 540 B.H.P. MARINE OIL ENGINE

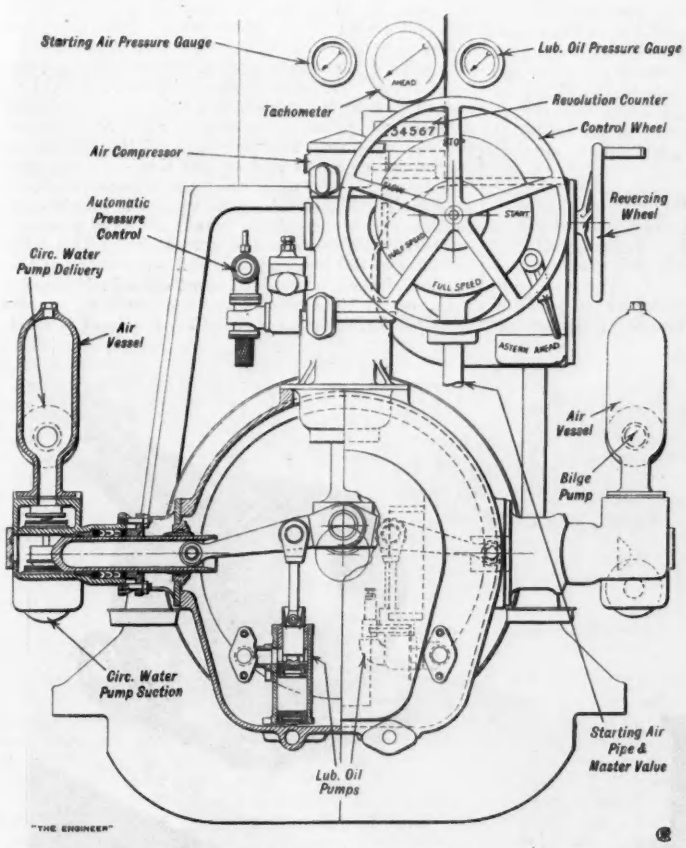


FIG. 5—PART SECTION OF CONTROL END

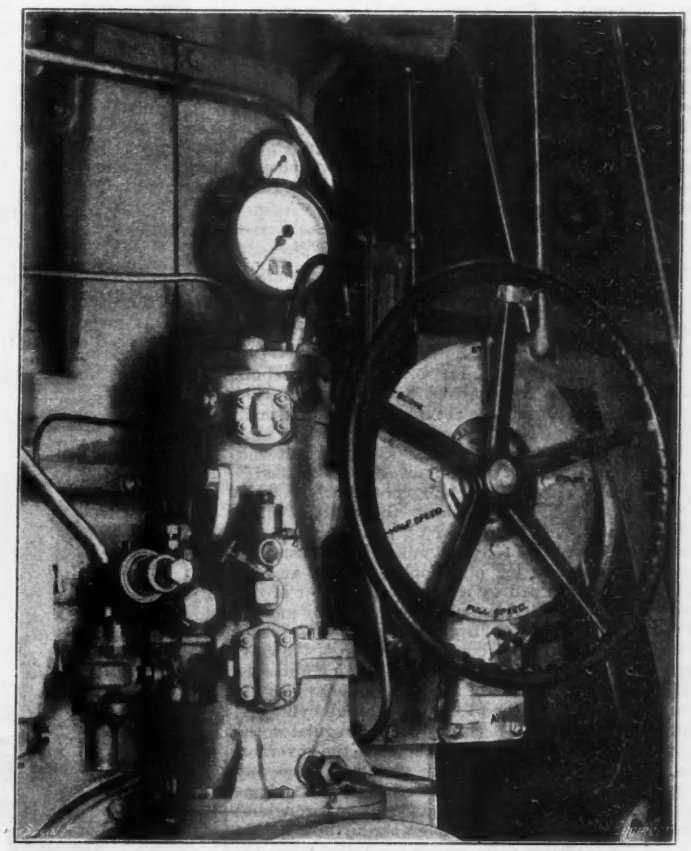


FIG. 6—CONTROL END OF ENGINE

engine crankshaft; the engine pump draws the oil from the sump tank and delivers it through a tubular cooler incorporated in the water inlet manifold and a double lubricating oil filter is provided, arranged so that either filter element can be cleaned while the other is in operation. A spring-loaded relief valve is incorporated in the oil pump delivery for adjustment of the lubricating oil pressure, excessive oil being by-passed back to the tank. Pressure gauges are mounted on the engine alongside the tachometer to show the pressure of the lubricating oil supplied to the engine and also the pressure in the starting air receiver. The general arrangement of the drives of the pumps and air compressor is shown in drawing Fig. 5 and engraving Fig. 6, which illustrate the neat manner in which the five units are driven.

A Michell thrust block is mounted on horns connected to the engine bed and forms an integral unit with the engine. The thrust block is water cooled by passing the compressor water through the thrust block and to the suction side of the bilge pump in order to keep the bilge pump always wetted.

The engine has been designed to work on any normal diesel fuel. Duplicate fuel filters of the Lolos type, arranged so that either filter element can be cleaned while the other is in operation, are provided. Arrangements are also made to fit an exhaust fuel heater on the engine exhaust pipe for dealing with fuels of high viscosity.

The Starting and Reversing System

The "ahead" and "astern" cams are mounted on the cam shaft for each valve; a push rod and a swinging arm with double rollers brings the correct roller for "ahead" or "astern" motion into use when the manœuvring shaft is rotated by the reversing hand wheel—see Fig. 5. Another wheel on the end of the engine controls starting air and fuel, being moved to an index plate marked "Stop, Start, Full Speed, Half Speed and Slow." This wheel and the manœuvring wheel are interlocked so that the manœuvring wheel can only be turned from "ahead" to "astern" when the fuel-air control wheel is in "Stop" position, and similarly the control wheel can only be moved from "Stop" position when the manœuvring wheel is fully in "ahead" or "astern" position. The starting air supplied to the various cylinders is controlled by a rotary distributor of the ported sleeve type and the sleeve is rotated by motion of the manœuvring wheel from "ahead" to "astern" setting. Motion of the control wheel from "Stop" puts starting air on all cylinders by opening a master valve, and when motion of the engine takes place the starting air is cut off and fuel put on to all cylinders. Further motion of the control wheel regulates the quantity of fuel and also is connected to the governor, putting load on the governor spring to give any required speed from idling to full speed. The engine is thus under the control of the governor throughout the full range of speeds, which has the advantage that should the propeller come out of the water when the engine is running at half speed the increase in speed is only some twenty revolutions. Similarly, with the engine under the control of the governor for idling, the minimum speed obtainable is lower than when idling is obtained by controlling the fuel only. There was no difficulty on this engine in idling at a speed of 85 r.p.m., and when the engine was warm 70 to 75 r.p.m. was obtained without misfiring on any cylinder.

The Governor Control System

A four-weight centrifugal governor is driven by bevel gears from the fly-wheel end of the cam shaft, and this governor controls the Bosch fuel pumps by means of control rods and lever mechanism. Separate fuel pumps are mounted on the centre line of each cylinder, giving a short fuel pipe to the injectors mounted in the centre of each cylinder head. A separate adjustment of the quantity of fuel to each cylinder can be made at each pump and also the timing of each pump can be adjusted at the pump plunger. The load on the governor spring can be increased by adjustment of a turnbuckle tensioner in the cable interconnecting the governor with the control wheel, temporary over-speed being obtained in this way. A tachometer is mounted above the control wheel and is driven from the engine cam shaft to show the speed of the engine and also the direction of rotation. The controls of the engine are arranged so that starting, stopping and speed variation can be operated from the bridge or from the engine as desired. An electrical tachometer is also driven from the engine, the dial being situated on the bridge to show the engine speed. The engine control units are illustrated in Fig. 6.

Recent Trial Results

A comprehensive series of tests was recently undertaken on this six-cylinder Mirrlees "HFR" engine, and the data derived have been plotted as the curves shown herewith in Fig. 7. The fuel consumptions were taken over a range of loads at constant speed of 300 r.p.m. and also by varying the speed according to the propeller laws for the power absorbed. The fuel consumption at full load, full speed was 0·36 lb. per B.H.P. hour, and, considering that the engine was driving its own bilge and water pumps and compressor, this can be classed as an extremely low consumption for an engine of this size. The tests under varying speed conditions show that the fuel consumption was below 0·4 lb. per B.H.P. per hour at all loads down to about three-eighths full load. The engine was tested for full output up to 330 r.p.m. and an idling test was taken for a period of half-an-hour at 85 r.p.m. With the engine warm it was possible to idle down to 75 r.p.m. without any signs of misfiring, the engine being under the control of the governor the whole time. The fuel consumption when idling at 85 r.p.m. was only 10 lb. per hour. Equal results were obtained on tests carried out when running astern. The engine is fitted with a fuel stop to regulate the maximum quantity of fuel which can be injected per stroke, and with this stop in operation a torque curve was taken to demonstrate that the engine would pull proportional power at any speed. It was demonstrated that the compressor fitted to the main engine would charge up the bottles from half to full pressure in half-an-hour, though, of course, the auxiliary set to be installed in the vessels would perform this service in a shorter time. A series of manœuvring trials was undertaken to demonstrate that the bottles were of ample capacity and, commencing with the bottles fully charged to 350 lb. per square inch, fourteen manœuvres were undertaken as quickly as possible on one 22 cubic foot bottle until the bottle pressure had fallen to 130 lb. per square inch. The time required for a full manœuvre from "full speed ahead" to "full speed astern" was eight seconds on the test bed. The time from "slow ahead" to "slow astern" was five seconds.

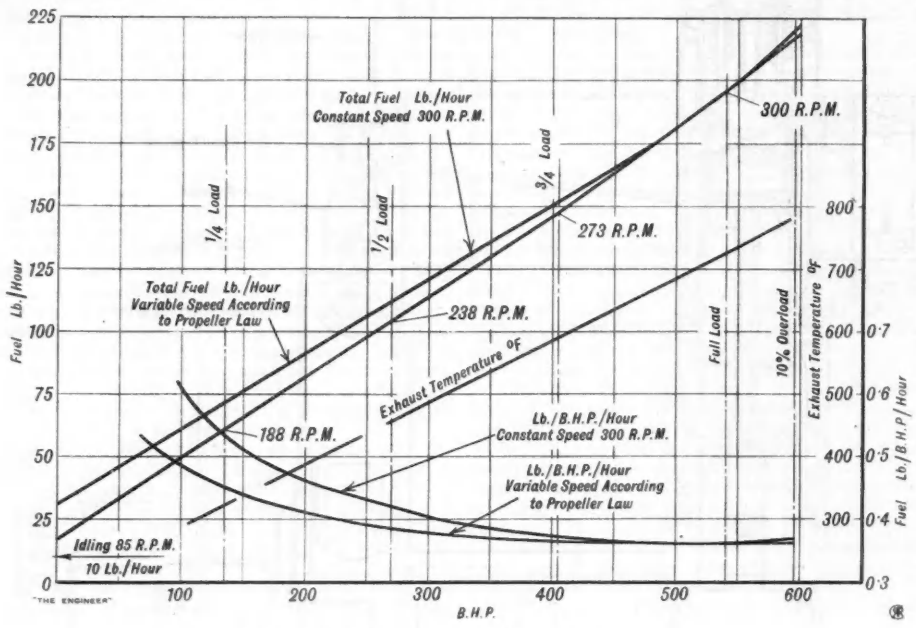


FIG. 7—TRIAL RESULTS OF 540 B.H.P. OIL ENGINE

Fuel Consumptions — Lb./B.H.P./Hour

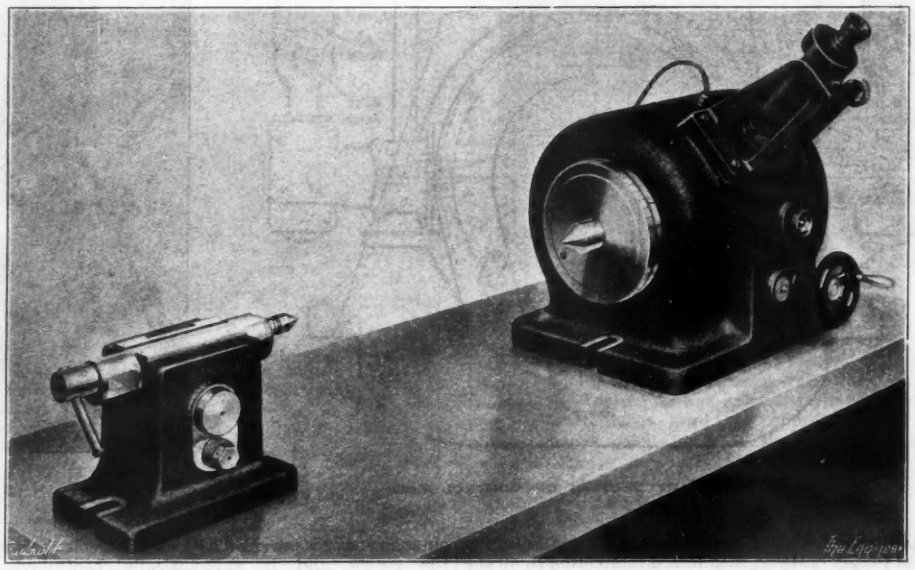
Load...	...	...	...	...	...	¼	...	...	½	...	...	¾	...	...	Full	...	...	10% O.L.
At 300 r.p.m.	...	...	...	...		0·525	...	...	0·415	...	...	0·370	...	...	0·360	...	...	0·370
At varying speed	...	...	...		0·45	...	...	0·382	...	...	0·363	...	...	0·36	...	...	0·365	

The Edgwick Optical Dividing Head

THE optical dividing head illustrated herewith has been designed by Alfred Herbert, Ltd., Coventry, in collaboration with and is manufactured by a firm of British toolmakers. The microscope is supplied by a well-known firm of optical instrument makers. It does not depend for its accuracy on mechanical means of division. Displacement of the spindle is read directly by means of the optical system, which is not subject to wear. The original accuracy of the head is thus maintained throughout its life.

The spindle of nickel-chrome, case-hardened steel, is rotated by means of a hand wheel operating a worm and worm wheel, but as no division plates are used any wear which may take place has no effect on the accuracy of the head. Provision is made for coarse and fine setting, the two-speed drive provided for this purpose being operated by means of a push and pull action of the hand wheel. A free position is also provided. The spindle is hollow and bored to take a No. 4 Morse taper shank, provision being made for ejection. The spindle flange is spigoted, drilled, and tapped to accommodate a "Coventry" chuck. Any other type of chuck can be used by fitting a suitable adapter. The nose end of the spindle is carried in a ground and lapped wear-resisting cast iron bearing. The rear bearing is of nickel-chrome, case-hardened steel. A thrust washer is provided at the rear end of the spindle to take the axial pressure.

The spindle bearings are accurately parallel with the base of the head and a small adjustment in the horizontal plane is provided to set the spindle parallel with, or at right angles to, the machine spindle or inspection table edge on which the head is used.



OPTICAL DIVIDING HEAD

This adjustment is effected by means of knurled screws acting on the tenon carrier plate. The spindle can be locked in any position by a knurled head screw, the locking pads being so arranged that no disturbance of the setting takes place.

Mounted on the spindle is a silver scale of a very high order of precision. This scale is divided into 360 deg., each degree being subdivided into 10 min. of arc. An optical micrometer within the microscope divides each 10 min. of arc into sixty parts, giving a reading of 10 sec. The divisions representing 10 sec. appear in the eyepiece to be about 1/25in. apart. Final readings can therefore be readily estimated to 2 sec. This refinement of accuracy can better be appreciated when it is realised that on a diameter of 4in. 2 sec. corresponds to a peripheral measurement of 0·00002in. The flange of the spindle is graduated in degrees for rough setting to avoid the necessity of continual observation through the microscope.

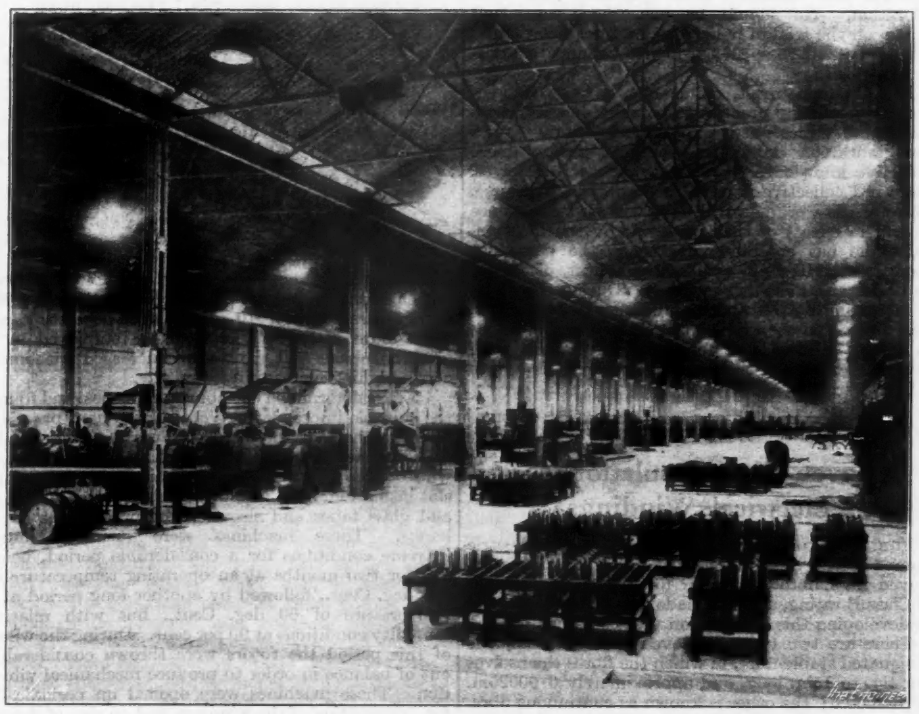
A low-voltage flash lamp bulb connected to a transformer or direct to a flash lamp battery is used to illuminate the scale. The heat generated by this small bulb is not sufficient to affect the readings of the dividing head. All the mechanism of the head is totally enclosed to exclude coolants and chips.

The tailstock has a hardened and ground spindle with excentric and vertical adjustments to align the centres. Adjustment in the horizontal plane is effected by turning the barrel in which the centre is mounted excentrically, and correction for height is made by means of a nut on the side of the tailstock. The alignment of the centres is checked by a dial gauge mounted on a trammel which is carried by an arbor between the centres. The dial gauge makes contact with the face of the spindle flange, the spindle being rotated and adjustments made to the tailstock until a constant reading is obtained.

Factory Lighting in War Time

THE general problem of providing efficient lighting in factories has been complicated by the introduction of difficulties caused by the war in connection with such matters as blacking out and danger from flying glass. These additional problems in existing factories have often demanded expensive solutions, and in some instances have necessitated modification of the normal lighting installations as well. Where new factories are concerned, however, the special war-time difficulties can be met in advance, and the only problem then is for the illumination engineer. Many new factories have recently been built to meet the demands of war production, and the methods of lighting adopted in one such, given over entirely to the manufacture of shell cases, are described below.

In this instance the question of protection against flying glass and that of providing efficient black-out arrangements do not arise—they have been dealt with simply by avoiding the use of all windows or roof glazing. The lighting system is therefore in operation for the whole twenty-four hours of the day, and particular attention has been paid to obtaining the most efficient illumination by entirely artificial means. The lighting installation and the accompanying wiring has been carried out by Metropolitan-Vickers Electrical Company, Ltd., by the use of 144 mercury units in double rows along the bays. An important feature of the installation is the length of the two main bays, which measure about 480ft. from end to end and 40ft. in width. Metrovick standard mercury discharge lamps of 400-watt and 250-watt capacity have been used throughout, giving a service illumination of 15 foot-candles. Care has been taken in choosing a light-coloured paint for the walls, and with a concrete floor and asbestos roofing, the reflection factor obtained is a considerable advantage to the general illumination. A very favourable impression of the lighting is gained by viewing the main bays from the ends, and, as the accompanying illustration shows, the light falling on the machines is quite sufficient to obviate the necessity of local lighting, except in one or two isolated cases.



LIGHTING IN A SHELL CASE FACTORY

Personnel and Procedure*

By G. A. CHEETHAM, M.I.E.E.†

THE personnel for engineering and design should possess good academic qualifications, supplemented by a practical training course, to give familiarity with the methods employed in the manufacture of the particular product with which the engineer has to deal. It is impossible for a junior to have a thorough training in both design and manufacture, and it is unnecessary for the junior engineer to start with more than a knowledge of general manufacture.

DESIGN

For small work it will be found necessary to have an experimental laboratory. Through this laboratory the junior engineers should pass before promotion to senior positions. In addition to this floating population a permanent routine staff will be necessary. This should consist of men capable of criticising the performance of any new product they may handle. They should therefore be familiar with the products of the organisation and are probably best recruited from the testing and inspection sections of the organisation. This forms an outlet for promotion for the best men in these departments with technical qualifications. The man in charge of this laboratory should be a good engineer, capable of criticising designs from the users' standpoint, and with sufficient authority to ensure that his criticisms receive consideration by the designing staff. He should continually be making contact with the selling organisation and users of apparatus, to develop their point of view, and thus be able to predict the reception a new piece of apparatus will receive. He should also be able to report from his contact with users the demand for apparatus not yet on the market, or existing apparatus not satisfactorily fulfilling its functions.

It is usually necessary to divide the engineering staff into sections, comprising the types of product with similar technical characteristics.

In the design of small apparatus, a difficulty is often experienced in precisely predicting performance by calculation. This is because variable factors—for example, friction, small magnetic leakage fields, paths of eddy currents in conductors—have very important effects on final performance. In consequence, experimental verification of results during progressive stages of design is necessary.

When the rough mechanical design is complete, a model is designed by a draughtsman and made up by a section of skilled craftsmen assigned to this class of work. This model is submitted to the laboratory for test, the designing engineer giving to the engineer in charge of the laboratory precise instructions as to the tests required. These requests must definitely be carried out by the laboratory without question, but the engineer in charge of the laboratory is invited to criticise constructively and destructively the apparatus submitted. The underlying object is to let the designing engineer have all the information he requires without question, but to make him feel that poorly designed apparatus will meet with a barrage of criticism.

If both men are of the right type this should result in consultation before submission of the apparatus, thus ensuring that the design is the product of more than one brain. When the model has passed its experimental stage it should be submitted to the chief draughtsman for consultation as to the finished design.

The chief draughtsman must be a good mechanical engineer and should have a staff of draughtsmen of the same calibre. It is essential that designs should be sound mechanically and it seems hardly necessary to emphasise this point. It is necessary, however, as many pieces of apparatus have failed to function correctly because the mechanical design was poor. Whilst the apparatus is passing through the drawing office for finished design, the manufacturing experts should be in close touch with the development to ensure that the design is suitable for manufacturing on available plant, and that improvements are introduced at various stages to overcome troubles that have been experienced in the past in similar apparatus. When the design is completed a final model should be made, which is circulated amongst the senior staff of both engineering and manufacturing departments, and any agreed modification carried out. The final drawings are then completed, and afterwards passed to the manufacturing department for tooling and processing.

The author holds strong views that no one man is capable of tooling and processing satisfactorily a new piece of apparatus, and is therefore strongly in favour of this work being carried out by a committee, whose main function is to ensure that the methods employed are the result of majority agreement. If this cannot be obtained, then the matter must be referred to the management for final decision. The committee, in the author's opinion, should consist of the tool engineer as chairman, a process engineer, the design engineer, draughtsman, efficiency engineer, and chief inspector. Various foremen are called in when the particular parts that they are to manufacture are under discussion. The committee's function is to decide on the type of tools, fixtures, and gauges to be made, the method of manufacture, and the operational times. The designer and draughtsmen are present to suggest changes in design if difficulty is met in manufacturing details which can be substantiated by something simpler. It is also a good plan for this committee to compare the number of detail parts on the design with apparatus of competitive manufacture, as obviously the minimum number of parts should be used to produce the necessary performance of the apparatus. In addition, the committee agrees on the manufacturing limits to be imposed upon various items where these differ from standard and the engineering department advise the manufacturing staff of the important parts which affect functioning and which require special care. It is very important that the inspection department should be informed of the functional requirements of the finished apparatus, and of the principal parts which affect its performance. It is the duty of the efficiency engineer to make records of the agreements reached and to take steps to see that the necessary process sheets, tools, requisitions, and operation sheets are issued in accordance with the agreements reached.

At this stage of the development, the estimator, who is usually a member of the engineering staff, is called in to prepare a complete estimate of the apparatus, and when completed the estimated prices of all details are supplied to the efficiency engineer. The complete duties of the efficiency engineer will be described later in the paper.

MANUFACTURE

Two main divisions of the manufacturing personnel seem to be indicated: (*a*) Those concerned with the supply of material and equipment, and (*b*) those concerned with the details of manufacture.

In the author's opinion, two distinct types of personnel are required to deal with the above two groups. The personnel dealing with the supply of equipment and material must possess a high degree of organising ability and a reverence for tidiness in method and practice. They should possess the ability to introduce sufficient system only to control the satisfactory working of the plant, without being

* From a paper entitled "Some Experiences in Organising the Design and Manufacture of Small Engineering Apparatus." Manchester Association of Engineers. December 14th.

† Metropolitan-Vickers Electrical Company, Ltd.

wedded to system. They should be capable of watching for changes in conditions, product, &c., which necessitate the revision of their existing organisation and should review their position from time to time to see that their system of organisation serves the company, and not that the company is a slave to the system. A continual effort should be made to keep the control down to the minimum to ensure efficiency.

The personnel necessary to control the details of manufacture should, as far as possible, be freed from the details involved in the system, and should be able to devote their entire effort towards producing the components in which they are interested in the best possible manner.

It is very important that any system adopted should leave room for the exercise of originality. Arrangements should be made that original suggestions are brought to the notice of the management, so that personal appreciation can be shown to the originator. It has been found of great advantage to have throughout the organisation a suggestion scheme, in which adequate rewards for improved methods are made. It is hopeless to install such a scheme unless the management treat the suggestor generously. Care should be taken also to see that the suggestions are submitted to some senior officer of the organisation or a committee to ensure that suggestors are not discouraged. Some arrangement should be instituted to ensure that suggestions accepted are put into force.

The personnel controlling the supply of material and equipment to the factory require grouping—again depending on the product. At the head of this organisation is an assistant manager or assistant superintendent, and under him are groups dealing with ordering of material, statistics, tool design and supply, and stores. An engineer is in charge of each section, reporting direct to the assistant manager. Sufficient statistics should be presented periodically to him to enable him to keep in touch with the efficiency of the department, but these should be kept as few as possible, consistent with efficient control. It is important that these statistics be in such a form that they can convey the impression intended in the least possible time. It is deplorable to see a statistical section presenting long lists of information which are not fully used because they take too long to peruse. When full scope is given to a man with a purely statistical mind he will present an incredible amount of information which is not of vital interest, and will proudly boast of his utility in proportion to the volume of work he produces. It is essential that the man in charge of the statistical section should judge his efficiency by the brevity and lucidness of the information he presents, and it will usually be found charts are the best method of compiling statistics.

The organisation concerned with the details of manufacture is either controlled by the same assistant manager concerned with the supply of material and equipment or by a person of equal rank whose duty is the details of manufacture only. In the latter case, the author feels it essential that the former should have the overriding authority, as when the details of manufacture of a particular article are completed the manufatcure then becomes a routine matter and is part of the general organisation. It is impossible to run as routine any project which is continually subject to change. The assistant manager in charge of manufacture, if such exists, should therefore handle the project whilst in its initial stages and should pass over the routine management of this project when it has reached something approaching stability.

The assistant manager in charge of manufacture handles all difficulties in connection with manufacture, and all developments of new products as regards manufacture. He should have a staff of manufacturing experts in particular processes, whom he can put into any section where development or investigation has to be carried out. It is recommended that this work be carried out under the supervision or direction of the foreman concerned. If this be not done, lack of interest, and even resentment, may be engendered in the foreman. In any case, no man will develop fully when handling only routine work. In the same section a laboratory devoted to manufacturing development should exist. Here investigations into new processes should be made, and the development of special purpose machines carried out. The staff of this laboratory should include an engineer thoroughly academically trained in mechanical principles, and with him should be a high-grade man who has had considerable experience in machining, so that the development can be conducted on sound engineering principles and, at the same time, on sound practical workmanship lines. Arrangements should be made to supply the staff of this laboratory with current literature on machine and manufacturing developments.

An efficiency engineer has been previously referred to. As mentioned earlier, this engineer records all the decisions with regard to the manufacture of new products, and it is his duty to see that these are carried out. His most important duty is to see that the estimated labour prices are met, which at first sight would seem all that is necessary. It is, however, possible for a piecework price to be met, but the process be unsatisfactory in that an abnormal amount of defective work is produced which may not become apparent to the management. The efficiency engineer's duty, therefore, is to record the defective account and to ensure that any abnormal items are brought to the attention of the management so that faulty processes and methods can be corrected. Naturally, it would be impossible to expect the estimate for every detail to be accurately met unless an abnormal margin was left in each estimate, which would probably not render the price competitive. The efficiency engineer's duty, therefore, is to see that the total labour price on a particular product is within the estimate, subject to no one item being abnormally in error. The efficiency engineer's records are therefore best kept in the form of cumulative prices plotted against the cumulative estimate, the progress of a new product therefore being apparent at a glance. If the abscissæ of such a curve shows the total operations to be performed in any section, the rate of growth of the curve also gives an indication of the rate at which process prices are fixed.

The chief inspector must obviously be familiar with the products of the company and have had a good engineering training if he is to make decisions which demand a practical solution. It is important to notice that the inspection department should not decide the standard of performance of the company, but should ensure that the standards set by the design staff are maintained. The lot of a chief inspector in a factory is a hard one, and he must possess a considerable amount of tact if he is to keep the quality of the factory product at a high pitch, and at the same time retain friendship and respect from those whose work he criticises. The inspection staff should, in general, not report to the manufacturing department. They should either report to the design staff or in a large organisation report directly to a director of the company. This is advisable as, human nature being what it is, there is bound to be a tendency on the part of manufacturing departments to consider output as the main factor of their existence, and subconsciously this may be obtained at the expense of a gradual deterioration of quality. The tool engineer in a manufacturing organisation must obviously be a man of wide experience in manufacture. He must also be encouraged to develop initiative and not merely be a designer of tools of the type which have been in existence for years. He should be encouraged wherever possible to visit outside factories, and be supplied with up-to-date technical literature in an endeavour to improve practice. As his work is essentially of a service character, he must receive suggestions from foremen and workmen with sympathy and consideration. He should be encouraged to spend money on the trial of new ideas, and not be severely criticised if all these ideas do not produce a satisfactory return.

The foreman must, of course, possess enough knowledge of shop practice to be able to assist workmen in difficulties. It is impossible to obtain respect from workmen unless the foremen possess more collective knowledge than the workmen themselves. The word collective is used, as on details, of course, many of the workmen will have acquired experience greatly in excess of that possessed by the foreman, unless he has actually carried out the particular operations. His main qualifications must, of course, be leadership, tact, and patience. During the stress of increasing output and manufacture of new parts, &c., difficult times arise, and everyone is apt to be on edge. Unless the foreman can handle such situations tactfully, the co-operative spirit is apt to suffer severely.

Woven-Glass Insulation for Electrical Windings*

FOR some considerable time the English Electric Company has been investigating the possibilities of woven-glass fibre insulation for electrical machines of Class B rating, and has made considerable progress in developing this material on practical lines.

There are two types of woven-glass material, one designated staple fibre, in which the fibres themselves are 4in. to 15in. long, and approximately 0·00025in. in diameter; the other is known as continuous fibre, and, as its name suggests, the fibres are drawn in continuous lengths. This latter material when spun and woven is much more satisfactory for electrical work than the staple fibre, as it is considerably stronger mechanically and presents a smoother finish and better appearance.

To illustrate how finely this material is drawn, it is of interest to note that a glass marble, $\frac{3}{4}$in. in diameter and weighing approximately $\frac{1}{2}$ oz. when melted in a specially constructed furnace and drawn through a die, produces a fibre 0·0002in. diameter of over 100 miles in length. These fibres are then spun into threads, the number of fibres varying with the required diameter of the thread produced. The threads are then woven into tape, cloth, and sleeving, the cloth and tape being made in thicknesses of 0·003in. and upwards. This material when treated with a suitable impregnating varnish can be used for high-temperature working. The combination of glass and impregnating varnish is resistant to moisture, acids and alkalis, whilst the tensile strength is far above that of asbestos, particularly at high temperatures.

Whilst glass in sheet form has a very high dielectric strength, it must be appreciated that when reference is made to woven-glass material, the dielectric strength is not truly comparable, as when woven materials are subjected to test between electrodes, the glass itself is not actually tested, but only the air spaces, which exist between the weft and warp threads in both woven cloths and tapes. Therefore the dielectric strength of the woven material depends entirely on the varnish which is employed to fill in these air spaces, and is therefore similar to woven silk and cotton materials which are varnished in a like manner.

Having obtained this woven glass which it was known was practically unaffected by temperatures up to 400 deg. Cent., the next step was to find a varnish which the company could either develop or obtain from outside sources, which would be unaffected by similar temperatures. After extensive research, the company has developed a thermal setting synthetic varnish which dries by heat only and not by oxidation. This varnish has been used extensively and found eminently suitable for use in conjunction with glass tape operating at temperatures approximating 300 deg. Cent., which is considerably higher than is practicable under service conditions.

Comparative tensile tests on woven-glass tape, 10 mils. thick and 1in. wide, and asbestos woven tape—the only comparable Class B material—show the following approximate breaking strength in pounds, at the temperatures indicated :—

Deg. Cent.	Continuous glass fibre tape.	Asbestos woven tape.
20	480	25
100	490	25
200	490	20
300	450	15

The test indicates a very much higher tensile strength for glass tape compared with asbestos, and this allows for a much more intimate application of this material, due to its higher tensile strength.

Glass materials compared with similar asbestos materials, both impregnated and unimpregnated, have a much higher electric strength and insulation resistance. Typical figures obtained are :—

	Breakdown voltage.	Breakdown stress volts/mil.
Untreated glass tape, 5 mils. thick	700	140
Untreated asbestos tape, 10 mils. thick	(Too leaky to give definite breakdown)	
Varnish-treated glass fibre tape, 10 mils. thick	7000	700
Varnish-treated asbestos tape, 15 mils. thick	3000	200

Insulation Resistance (Megohms) of 1in. square of Tape.

Days at 90 per cent. relative humidity and 20 deg. Cent.

	Varnish-treated glass fibre tape.	Varnish-treated asbestos tape.
0	Infinity	2·5
1	,,	2·5
2	,,	0·35
7	15	0·05
14	15	0·07

These results, coupled with the high values of tensile strength, make it possible to substitute 5 mils. woven-glass tape for 10 mils. woven-asbestos tape. Thus more active material can be employed in a given machine, and the output increased without a corresponding increase in frame size.

Having determined the above properties, and found the suitable impregnating varnish, the next practical step was the construction of two mush-wound 5 H.P. induction motors, using double glass-covering on the wire of the stator conductors, mica and glass cloth slot insulation, mica insulation between the coil sides, and glass tapes and sleevings for bracing the overhangs. These machines were operated under extreme conditions for a considerable period, being run for two months at an operating temperature of 230 deg. Cent., followed by another long period at a temperature of 60 deg. Cent., but with relative humidity conditions at 90 per cent. During the whole of this period the rotors were thrown considerably out of balance in order to produce mechanical vibration. These machines were opened up periodically for examination of the windings and no sign of deterioration was found. The windings were impregnated with the thermal setting synthetic varnish previously referred to, and were in perfect condition after two months' operation.

Conjointly with the above experiment, the company constructed several trolleybus and railway motors, which represent the most severe conditions under which machines are likely to have to operate. These machines were completely insulated with woven-glass materials, combined with mica, and were found to operate very satisfactorily, both at home and abroad. In view of this experience, all the company's latest trolleybus motors are glass insulated, the shunt windings of the compound field coils being wound with double glass-covered wire, and the mica insulation being reinforced with woven glass tapes and cloth. The armature coils are taped throughout with woven-glass tape.

For a contract comprising sixteen railway motors,

* From an article by C. D. Jamieson, A.M.I.E.E., in the *English Electric Journal* for November, 1940.

in course of construction for a British railway company, the motors incorporate all-glass and mica insulation. Six new designs of machines have been developed in connection with special Diesel-electric equipment. These machines include railway motors, generators, and exciters. In all these, glass insulation has been used throughout, including the insulation under the wire bands which has been reinforced with woven-glass material. Large quantities of woven-glass materials are also used in conjunction with mica for the insulating of steel works motors and generators, and for Class B rated machines for marine service.

The company has extended the use of woven-glass tape to its 3000 r.p.m. turbo-alternator rotors. The increased tensile strength of the glass tape makes it possible to obtain a much more intimate contact between the insulation and the windings, which results in a very neat finish. On the industrial side, a large number of motors are in course of manufacture, the armatures of which incorporate no cotton or asbestos. The field coils are insulated with asbestos-covered wire, and the outer insulation is glass tape used in conjunction with mica.

Sixty Years Ago

TORPEDO BOAT DESIGN

THE torpedo boat of sixty years ago was a shallow-draught, low-freeboard, high-speed launch, with a conning tower forward, a funnel aft and the whole upper surface covered by a turtle-back deck. A typical example built by Yarrow and Co., of Poplar, had a length of 86ft., a beam of 11ft., and a displacement of about 32 tons. She was fitted with engines developing a little over 500 I.H.P. The bow was shaped to serve as a ram. The line of the keel was swept upwards from about the 'midship section in a continuous curve to the stern, which in elevation was brought to a sharp point. The propeller shaft passed through the bottom of the hull at a point close to the 'midship section and was extended aft through a bracket at a point about a quarter of the ship's length from the stern. It was argued that the propeller placed in this position would have the advantage of operating in water of greater density than would be the case if it were placed in the usual position at the stern. The profile of the boat as illustrated in our issue of January 14th, 1881, certainly seemed to promise a high speed. On trial, however, the results were very disappointing. With the utmost power that could be developed the speed achieved did not exceed 18½ knots. Mr. Yarrow, with obviously the intuition which marked the whole of his career, decided that the fault lay with the position of the propeller, and that improved results were to be expected by restoring it to its usual position at the stern. This alteration meant sacrificing the sweep up of the keel over the after half of the ship's length. The hull was reconstructed with the keel line straight and horizontal from the 'midship section right to the stern with the propeller shaft enclosed for the whole of its length within the hull. The wetted surface was increased by this alteration. Nevertheless, after it had been made the boat achieved a maximum speed on trial of 21½ knots. At 18½ knots, its former maximum speed, the engine power required was only 400 instead of 500 I.H.P.

RIGID FRAME BRIDGES IN AMERICA

As part of an extended investigation of various features in the design of rigid-frame bridges of reinforced concrete, tests of structural hinges in concrete members have been made at the engineering experiment station of the University of Illinois. These tests were undertaken for the reason that in many cases it is desirable to introduce some form of articulation at the bases of vertical members in concrete rigid-frame bridges. This applies particularly to long spans, where high deformation stresses would otherwise occur at these points, due to temperature changes and concrete shrinkage. Information as to the structural behaviour of various forms of hinges adaptable in bridge design was the purpose of the tests. Requirements for a satisfactory hinge are that it should be capable of withstanding compressive forces as well as shearing forces, should be sufficiently flexible to permit a specific angular rotation, should be economical in construction and should require a minimum of maintenance work in the structure. The specimen hinges were tested for elastic and ultimate strength under vertical and inclined loads, and their resistance to angular rotation. They included rectangular and semi-cylindrical socketed joints, reduced cross sections in the members, and a joint in which the corner of an angle iron in the lower parts of the member was seated in the fillet of a similar angle iron in the upper part of the member. The measured strength under vertical load was equal to and in some cases greater than the calculated strength. Under oblique or inclined loads most of the hinges developed ultimate strengths that compare favourably with the requirements of highway bridges of medium single spans. All but one permitted ample angular rotation without structural damage to the hinge.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

Exports to the Argentine

The *Journal* of the British Chamber of Commerce in the Argentine Republic has some cheerful news regarding imports from Great Britain. Although the real value of that country's purchases from all sources was less in September, 1940, than during the preceding month, the tariff value of imports from Great Britain rose from 17·8 million pesos in August to 18·7 million pesos in September last. It could hardly be expected that the exports from Great Britain to the Argentine in 1940 would equal those of 1939, but the difference is not so great as might have been feared. In the first nine months of 1940 the total tariff value of British imports amounted to 176,983,085 pesos, whilst for the corresponding period of 1939 the total value was 200,103,700 pesos. Great Britain and the United States are the two principal sources of supply for the Argentine, and the United States has naturally benefited from the war conditions which have been ruling. In September, 1940, the tariff value of imports from the United States was 28,847,330 pesos, and for the first nine months was 261,540,096 pesos. Commenting upon these figures the *Journal* points out that it is "not altogether surprising that the value of imports from the United Kingdom in September, 1940, was below the corresponding figure for the war outbreak month of September, 1939, when deliveries had barely experienced the effect of a state of hostilities. To carry the point still further, it is of interest to observe that the tariff value of Argentine imports in September last was substantially in excess of the figures shown in any one pre-war month in 1939." The *Journal* contains a report of a speech by Mr. C. B. Jerram, the Commercial Counsellor to the British Embassy, who assured his audience that "Great Britain was making determined efforts to meet as many as possible of the Argentine's requirements. Arrangements were being made to supply all commodities such as tin-plate in adequate quantities. In addition an allocation of steel for the production of goods for export has been made for the forthcoming period estimated to suffice all inquiries received."

The Pig Iron Market

The opening of 1941 finds the situation in the pig iron market fairly satisfactory. Practically all the consuming trades have full order books and are wasting no time when they have obtained their licences in covering their requirements for the first three months of the year. This has given the market an appearance of great activity. Usually the beginning of the New Year is a period of dull trading, but under the conditions now ruling the Christmas holiday season has had no appreciable effect upon business. On the North-East Coast the makers, under the direction of the Control, are concentrating upon the production of basic iron and have little foundry pig iron for sale. The foundries in that district are receiving the greater part of their supplies from the Midlands, and the Scottish foundry trades are also using large quantities of iron from this district. The position, however, seems comfortable, since, apart from a few transport troubles which have not been serious, the supplies have reached the consuming industries with regularity and have been adequate and the production is obviously sufficient to cover all requirements. The supplies of high-phosphoric iron are sufficient to meet all calls upon them and deliveries have increased with the development of better conditions at the light castings foundries. Government contracts have helped this industry and, in addition, there has been more demand for light castings of a commercial character for reconstruction work. In the Lancashire market conditions are somewhat irregular. There is only a moderate demand from the textile machinists, whilst the jobbing foundries have a considerable amount of miscellaneous work in hand and are taking up good tonnages. There is a heavy demand for hematite pig iron, and whilst the position is not stringent, it will probably be necessary to continue importing this quality to meet consumers' requirements.

The Midlands and South Wales

The year 1941 commenced with intense activity ruling at the Midland steel works, and whilst there have been times during the past three months when the request for certain descriptions of steel has shown signs of falling-off, at no time has the total demand declined. If there has been a slackening in consumers' requirements of one sort of steel, an increased call in other directions has more than made up for it. Recently there has been a particularly heavy request for special steels from the munition makers, and the production of this class of material has considerably increased. Although some of the constructional engineers are less busy than a month or two ago, substantial tonnages of joists and sections are passing into consumption. The demand seems chiefly for the lighter and medium sizes, and as a consequence the steel works and the re-rolling mills are carrying heavy order books. In a large number of cases works will carry over into the first delivery period of 1941 big tonnages of miscellaneous orders. Amongst the principal consumers of steel, the shipyards and the ship repairing yards rank high, and a steady stream of plates and other shipbuilding material is moving in that direction. A large programme of new construction is in hand on Government account, and the requirements of the shipyards are not likely to diminish for a long while. Colliery steel continues in request and, despite the continuous demand which has ruled for some months, there are no signs of a decline in consumers' requirements. The South Wales market has shown little change over the last quarter of the year. The pressure from consumers to obtain delivery has been uniformly insistent, and all the iron and steel works are operating at capacity. The volume of business in tin-plates, which declined in November, is again rising. In this section the quantity of steel available is controlled owing to the need for it in other directions.

The North-East Coast and Yorkshire

The steel works on the North-East Coast are producing at a high rate and these conditions are likely to continue indefinitely. All the works have big order books and will carry forward into the new delivery period big undelivered tonnages. At the end of each period the outstanding balances are reviewed, and it is possible that the Control will not allow all of these to remain on the books of the steel makers. As most of the orders, however, are for firms engaged upon war work it is probable that the greater part of the undelivered orders will have to be dealt with. The situation is satisfactory so far as raw supplies are concerned, and the steel makers have no grounds for anxiety on this score. The works producing semis are working under extreme pressure, but their production is insufficient to meet the requirements of the finishing industries; nevertheless, the flow of semis from the United States and Empire countries is sufficient to bridge the gap between home production and home requirements. The structural engineers remain busy and are responsible for taking up large quantities of joists and sections. The demand for the heavier joists has fallen off somewhat during the past few weeks, but there has been no decline in the demand for the lighter sections. Both the steel works and the re-rollers are fully employed and the outputs of the latter have been on a heavy scale. The demand for bars, both large and small, has been well maintained and considerable tonnages are passing into consumption. The big programme of naval and other shipbuilding work under construction is responsible for a heavy demand for plates. There is some tightness in this department and firms who are not engaged on war work do not find it easy to obtain their full supplies. The conditions in the Yorkshire steel industry have not changed much in the past few weeks and production is pressed to the utmost. In the Sheffield district large tonnages of basic steel are being turned out.

Copper and Tin

Following the Christmas holidays there was active buying, as consumers covered their requirements over the early weeks of the New Year. Whilst no statistics are available it is understood that the copper position is satisfactory and that there is no likelihood of any firms engaged upon national work having to curb their rate of operations owing to a shortage of metal. Supplies from Empire sources continue to arrive with regularity, and if any cargoes have been lost as a result of Germany's attempted blockade it is not reflected in tight conditions in Great Britain. In the United States the demand is strong and appears to be growing with the development of the rearmament programme. Producers continue to allocate quantities to their customers, but the domestic price is held at 12c. d/d. It is estimated that in December deliveries amounted to 90,000 tons and for the whole of last year to 1,110,000 tons. This indicates a heavy consumption in the United States, but it is anticipated that, large as it is, it will further increase, and that copper will have to be obtained from South America. There is, naturally, some reluctance to adopt this course, but it is argued that if the United States buys this metal it will prevent sales, to which the Government is for political reasons opposed, to certain other countries. Export business in copper is dull and although the price is nominally 10½c., it is understood that bids have been made by Japan at 12½c. Apparently, however, the American producers take the line that they cannot spare the copper owing to their domestic needs. . . . The position in the tin market appears to be becoming rather complicated since, according to statistics of tin published by Mr. W. H. Gartsen, the total visible supply at the end of December was 39,066 tons, compared with 33,127 tons at the end of November, an increase of 5939 tons. The monthly supplies were 17,812 tons during December, compared with 13,397 tons during November. The deliveries, however, were down at 11,873 tons, against 14,581 tons in November. It will be seen, therefore, that there are ample supplies of tin. In fact, suggestions are made that the quantities available are more than the world needs with so many consuming countries cut off as a result of German occupation. Rumours have been afloat that at its next meeting the International Tin Committee will be asked to readjust the export quotas of the different countries. This, however, would probably arouse considerable opposition from those countries whose quotas were reduced. The issue of export licences has been resumed by Great Britain, but applicants only get a proportion of the tonnage asked for.

Lead and Spelter

In Great Britain the lead position remains satisfactory, more so probably than in the case of any other non-ferrous metal, although the position in this respect generally is regarded as comfortable. Not only do firms engaged in national work obtain all the metal they require, but lead is available to those makers producing goods for export. The official statement that local councils are engaged in building houses for munition workers and others engaged upon national work points to a revival in the demand for lead for domestic purposes. Probably the number of building schemes of this description which will be permitted will be greatly restricted, but it will certainly call for a fair amount of lead. In the United States there is a steady demand and the price remains unchanged at 5½c., New York. Supplies in that country appear free and consumers find no difficulty in obtaining the metal they require. . . . The characteristics of the world spelter position have not changed. In most countries stringent conditions rule and seem likely to prevail for the duration of the war. The supplies of spelter to Great Britain are adequate to meet all calls from firms engaged upon national work, but there is not much surplus. The consuming industries, particularly the brassmakers, are fully employed and are producing at a high rate. In the United States the market is rather tight and the price is held at 7·25c.

Notes and Memoranda

Rail and Road

THE SOUTH MANCHURIAN RAILWAY.—It is reported from Berlin that the European office of the South Manchurian Railway will be transferred from Paris to Berlin in the near future.

JAPAN BUILDS A NEW LINE.—The Japanese having secured Nanning, in Kwangsi Province, have begun the construction of a narrow-gauge railway to that city from the Kwangung coast, a distance of about 60 miles.

CHINA REBUILDS A BRIDGE.—The bridge on the Shanghai-Hangchow-Ningpo Railway over the Chien Tang River near Hangchow has been rebuilt and re-opened for traffic. The Chekiang-Kiangsi Railway, which connects with the Shanghai-Hangchow line near the bridge, is still partly under Chinese control.

BRAZIL BUYS LOCOMOTIVES.—An order for twenty-six locomotives was placed by the Ministry of Transportation and Public Works of Brazil and was divided equally between the Baldwin Locomotive Works and the American Locomotive Company. The Brazilian and Bolivian Governments have placed orders for four "Mogul" type locomotives with the Vulcan Ironworks.

ROAD SAFETY DEVICES.—The South African Government has given notice that a fee of not less than £10 10s. must be paid to the Secretary for the Interior by any private firm or person on each occasion when such firm or person submits to the Road Safety Research Committee, for investigation and report, a safety device or patent relating to road traffic and likely to be of commercial value to designer or patentee.

SPAIN SHORT OF FUEL.—The Spanish railways are suffering from a shortage of fuel. Although the Asturian coalfield supplies the greater part of the locomotive coal used, English coal has always been used for express services. The position is further complicated, says the *Railway Gazette*, by the shortage of motor fuel and its high price. All road motor transport parallel to railway lines has been prohibited and even urban motor-bus services have stopped. The consequent reduction in road transport has thrown on the railways a huge volume of additional traffic which in present circumstances they can carry only with great difficulty. The loss of rolling stock through destruction and neglect during the civil war was very serious, and the shortage of wagons has not yet been made up.

GAS CYLINDER REGULATIONS.—The Compressed Gas Cylinders (Fuel for Motor Vehicles) Conveyance Regulations, 1940, just published by H.M. Stationery Office, stipulate that cylinders must be constructed by an approved manufacturer, must conform to one of two specifications laid down in the regulations, and are limited to a pressure of 3000 lb. or 1800 lb. per square inch, according to which specification is followed. In addition, all cylinder valves and fittings must conform to a certain specification. A fusible plug, designed to fuse at 150 deg. Cent., or a bursting disc designed to operate at 1½ times the working pressure of the cylinder, must be fitted and kept in working order. All cylinders must bear the manufacturer's identification marks, letters indicating which of the two specifications given in the regulations has been followed, and the date of the last hydraulic stretch test, to which cylinders must be submitted at some date during the two years previous to use.

THE WAGON HOLD-UP.—Germany is as concerned for the hold-up of wagons as our own authorities. A recent appeal to traders ran thus :—"Make every effort to hasten the loading and unloading of wagons, by better organisation, by more practical arrangement of work, and by the use of labour-saving appliances. Use the loading space to the last cubic metre and load the wagon whenever possible to the full official loading capacity—for internal German traffic it is now permissible to load the wagon up to a ton higher than the official loading capacity. Goods wagons can fulfil their purpose only while they are being moved. Every hour in which they remain unused—it does not matter whether the wagon is standing empty or loaded—means the waste of valuable loading space, and unnecessary delay in the movement of freight. If it is possible to shorten the standing time of the wagon by 10 per cent., the result is that hundreds, even thousands, of extra wagons are made available to industry daily."

Air and Water

SHIPPING LOSSES.—Mercantile losses by enemy action during the week ended December 30th were three British ships amounting to 18,208 tons and four Allied ships amounting to 19,348 tons. The total tonnage lost was therefore 37,556.

PLASTICS FOR AIRCRAFT.—The Canadian Department of Munitions and Supply has obtained the exclusive right to "Vidal," a plastic process for aircraft production in Canada, and has ordered two plastic fuselages to be given destruction tests.

AIRCRAFT CONTRACTS.—The American Government has placed a 122,323,020-dollar contract for 3000 aircraft engines with the Ford Motor Company, Dearborn, Mich.; a second 11,436,042-dollar contract for Army and Navy aircraft with the Wright Aeronautical Corporation, Paterson, N.J.; and another by the War Department of 8,074,406 dollars to the Colt's Patent Fire Arms Manufacturing Company, Hartford. This calls for the installation of additional equipment for the manufacture of infantry weapons.

A LIFEBOAT'S ROMANCE.—The "Jane Hannah" is a North-East Coast lifeboat with a more than usually exciting history. After serving for a time at Flamborough, she passed into the fishing fleet to become last year a unit in the Dunkirk venture. She was afterwards lost at sea and tossed helplessly in the English Channel for ten days before being picked up by a destroyer and towed to a British port, whence she was conveyed by L.N.E.R. to a river yard for overhaul. That done, the railway company undertook the task of re-launching her. She weighs 5 tons, and as no slipway was available, the launching was effected by crane from a railway bridge crossing the stream.

Miscellanea

THE USE OF CEMENT.—A leaflet on the economical use of cement is obtainable, free of charge, on application to the Building Research Station, Garston, near Watford. It is not issued by the Stationery Office.

A LIQUID AIR PROCESS IN RUSSIA.—The Commissariat of Heavy Machine Building of the U.S.S.R. is building plant in one of its factories for the manufacture of liquid air and oxygen by a method due to Professor P. L. Kapitza, Director of the Institute of Physical Problems of the Academy of Sciences of the U.S.S.R.

SHALE OIL FOR SWEDEN.—The Swedish Minister of Commerce has submitted a Bill to the Riksdag, asking for Kr. 15,000,000 for launching a shale oil company. It is proposed to build a shale oil works capable of supplying Sweden's domestic requirements. The cost of the shale oil, however, is likely to be from three to four times as high as that of imported crude oil in normal times.

BRASS PLATING.—An American concern has developed an improved brass plating process, said to be two to four times as fast as present processes. It provides a brass plating method which will yield smooth bright deposits of controllable thicknesses at a rapid rate of deposition. The process makes possible heavy deposits of brass, 0·001in. or more in thickness, in a reasonable time where before heavy deposits could not be obtained at all.

LABOUR IN WAR TIME.—A memorandum on the efficient utilisation of labour under war conditions, prepared by a committee of the Institution of Production Engineers, states that "the problem for which a solution has to be found is one of ever-increasing demands for skilled engineering labour with a totally inadequate supply from which it can be drawn. . . . The objective should be to make the task fit the type of labour available rather than wait until labour is trained to a standard suitable to handle the ordinarily accepted lay-out of operations."

INDUSTRIAL DIAMONDS.—In an annual report published in South Africa by the Mineral Research Laboratory, attention was called by the Government Mining Engineer to an investigation into possible further uses of industrial diamonds, particularly as regards rock drilling. This had reached a point at which it was felt that further development could best be undertaken by the industry itself, and accordingly research at the Laboratory had been discontinued. The Laboratory had, however, indicated its willingness to assist in special matters within its scope if occasion should arise.

STANDARDS OF ACCURACY.—At a recent meeting of the U.S.A. National Tool Builders' Association it was revealed that the lathe group had adopted a set of "Standards of Accuracy for Engine Lathes" and had presented the standard to the American Standards Association for adoption. The standards provide tolerances of error on all major functioning parts of the lathe, from alignment of the bed to run-out of the spindle nose and backlash in the feed screws. Early acceptance by the A.S.A. is expected. Meanwhile, the standards have already been put into effect by the lathe manufacturers.

A NEW WIRE PROCESS.—An oil-tempered wire for special mechanical springs is now being produced by an electric direct resistance method by Jones and Laughlin Steel Corporation, Pittsburg, Pa. In contrast to the conventional methods of heating wire to quenching temperatures, either in furnaces or by immersion in molten baths, this process consists of passing sufficient electric current through the wire to heat it. The new equipment handles a wide variety of gauges, and is so constructed that wire fed from reels passes first through tension rollers, then through a molten electrical contact. Advantages of the process include the exactness with which all factors affecting the ultimate quality of the wire are controlled.

FIRES IN WAREHOUSES AND STORES.—The North-Western Regional Commissioner (Sir Harry Haig) has issued directions for preventing fires in warehouses of a greater capacity than 100,000 cubic feet in the Manchester area. These include the maintenance of lengthwise and cross gangways at least 3ft. wide and the provision of fireproof covers over all apertures connecting warehouse floors. Where there are more than four storeys, the top storey must be cleared of all but permitted goods or essential or non-inflammable fixtures, and where there are not more than four storeys stacking in the top storey is limited to 6ft. below the roof timbers. If timbers are treated with fire-resisting paint, goods may be stacked to within 3ft. of them. Clear spaces on timber floors have also to be treated with fire-resisting paint.

PERUVIAN MINERALS.—In the summer of last year the Banco Minero del Peru (the Mining Bank of Peru) was established by law for the purpose of granting credits to stimulate the exploitation by domestic firms of minerals existing in the country. The funds are to be obtained from taxes on the mining industries previously established in Peru. The capital of 50 million soles will belong to the State and will be obtained by export taxes of 2 per cent. on the value of the gold contained in minerals, bars, concentrates or other metallurgical products ; 2 per cent. *ad valorem* on minerals, concentrates, bars and metallurgical products of vanadium, tungsten, molybdenum, manganese, tin, natural gas and natural gasoline ; and 1 per cent. *ad valorem* on all minerals not mentioned above, including crude oil, as well as derivatives and liquids or gaseous products of refining. Minerals, bars, concentrates and metallurgical products that contain mixtures of the metals named will be subject to the corresponding taxes as outlined.

APPEAL FOR OLD LINEN DRAWINGS.—As a result of the appeal for old linen drawings, issued some time ago by the Building Centre, London, thousands of pieces of first-class linen have been salved and well over £2000 worth have been passed on to the Women's Voluntary Services, who have distributed it amongst their various branches. Hundreds of articles have been made, such as aprons, pillowcases, surgeons' caps and masks, bandages and handkerchiefs, &c. The W.V.S. say that the demand from their branches is now so great that all those who can do so should be urged to send more bundles of old linen tracings for which they have no further use. They should be sent, addressed to Mr. F. R. Yerbury, Director, The Building Centre, 158, New Bond Street, W.1, where they will be quickly dealt with and every care taken to see that they are utilised for no other purpose than that for which they are asked.

Personal and Business

JOHNSON AND PHILLIPS, Ltd., inform us that Mr. W. Glass, A.M.I. Mech. E., has been appointed a director of the company.

THE Association of Drop Forgers and Stampers informs us that its address is now C.2, Kenilworth Court, Edgbaston, Birmingham 16.

MR. J. S. TRITTON is acting temporarily as Honorary Secretary of the Diesel Engine Users Association, in place of Mr. H. V. Stead who is serving with the R.A.F.

MR. O. GLYNNE ROBERTS has retired from the position of Secretary and Assistant to the President of the London Midland and Scottish Railway. His successor is Mr. G. Royde Smith.

COLONEL J. TENNANT, D.S.O., D.L., M.I. Mech. E., has retired from his position of works manager of the Prescot works of British Insulated Cables, Ltd. He will be retained as consultant on plant matters to the company and its subsidiaries until further notice. Mr. D. W. Aldridge, who has been assistant works manager, has been appointed works manager.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Bradford Engineering Society

Monday, Jan. 13th.—Technical College, Bradford. "Reinforced Concrete," G. McLean Gibson. 7.15 p.m.

Illuminating Engineering Society

Tuesday, Jan. 14th.—E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, W.C.2. "The Fundamental Principles of Vision in Very Weak Light," W. D. Wright, and Report on "War-time Street Lighting and Aids to Movements in Streets." 2.30 p.m.

Institution of Automobile Engineers

Saturday, Jan. 11th.—LONDON GRADUATES : 12, Hobart Place, S.W.1. "Some Mechanical Aspects of Bus Operation," A. C. Creed. 3 p.m.

Saturday, Jan. 25th.—LUTON CENTRE : George Hotel, Luton. "Producer Gas for Road Vehicles," M. Platt. 2.45 p.m.

Institution of Chemical Engineers

Tuesday, Jan. 14th.—Geological Society's Rooms, Burlington House, Piccadilly, W.1. "Modern Developments in the Design of Plant for the Concentration of Sulphuric Acid," P. Parrish. 2.30 p.m.

Institution of Civil Engineers

Tuesday, Jan. 21st.—Great George Street, Westminster, S.W.1. "The Design of Sewage Purification Works," H. C. Whitehead. 1.30 p.m.

Institution of Electrical Engineers

Tuesday, Jan. 14th.—SCOTTISH CENTRE : Royal Technical College, George Street, Glasgow, C.1. "Electrical Contracting, including some Aspects of Transmission Line Construction," H. M. Speirs. 6.15 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, Jan. 14th.—39, Elmbank Crescent, Glasgow. "District Heating," D. V. H. Smith. 6.30 p.m.

Institution of Mechanical Engineers

Friday, Jan. 24th.—Storey's Gate, Westminster, S.W.1. Presentation of James Watt International Medal. Lowe Gray Lecture, "Progress in Marine Engineering as Influenced by the Classification of Ships," S. F. Dorey. 2 p.m.

Junior Institution of Engineers

Saturday, Jan. 11th.—39, Victoria Street, S.W.1. "Electrical Wiring Regulations and their Application," E. H. Watton and T. Hall. 1.30 p.m. MIDLAND SECTION : James Watt Institute, Birmingham. "Some Problems of Electricity Distribution," D. Birch. 3 p.m.

Saturday, Jan. 25th.—39, Victoria Street, S.W.1. "Protective Coatings on Metals," P. A. Cartwright. 1.30 p.m.

Manchester Association of Engineers

To-day, Jan. 10th.—Engineers' Club, Albert Square, Manchester. "Woodworking Machinery : Recent Developments in Design," R. H. Buckley. 7.15 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Wednesday, Jan. 15th.—STUDENTS' SECTION : Bolbec Hall, Newcastle-upon-Tyne. "Poppet Valve Steam Engine," W. G. Brown. 6.45 p.m.

Friday, Jan. 17th.—Mining Institute, Newcastle-upon-Tyne. "Optical Instruments : Particularly Large Astronomical Telescopes," G. E. Manville. 6 p.m.

Royal Society of Arts

Wednesday, Jan. 15th.—John Adam Street, Adelphi, W.C.2. "Women in Industry," Miss C. Haslett. 1.45 p.m.

Wednesday, Jan. 22nd.—John Adam Street, Adelphi, W.C.2. 'Flight Refuelling," Sir Alan Cobham. 1.45 p.m.